



The Blast Furnace and Steel Plant

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The Blast Furnace *and* Steel Plant

VOL. IX.

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No. 8

Rotary Kiln Lime Burning Plant

New Plant Recently Built at the Granite City Steel Works of the
National Enameling and Stamping Company, Granite City, Illinois

DURING recent years the delivery of material according to manufacturing needs has been a problem, particularly where such material could not be stored for any great length of time. This transportation difficulty was one of the reasons for the installation of a lime burning plant at the steel works where the raw material or limestone could be stored in sufficient quantity and burned to meet requirements.

This plant consists of building and equipment for raw material, two rotary kilns eight feet diameter by 110 feet in length, which are not housed, building at finishing end which houses the electrical control equipment, pulverizers, storage for coal at pulverizers and storage for finished lime. Reinforced concrete construction was used throughout for the main buildings and storage bins.

Since labor costs are a very serious factor in present day operation, the plant has been designed to operate with a minimum force, this being accomplished by the

mechanical handling of material and by a convenient arrangement of the equipment. All raw material is received on one track and passed into the "raw end" of the plant. Lime stone is delivered to the plant by rail in $1\frac{1}{2}$ to $\frac{5}{8}$ " size. The fines below $\frac{5}{8}$ -inch are screened out at the quarry. If received in dump cars, the stone may be dumped directly to the storage bins, which are below the track level or if received in solid bottom cars, a crane is used for unloading either directly to the overhead bins which supply stone to the kilns or to the storage bins below the track level from which the stone is handled to the overhead bins by the crane. Coal is also received at this end of the plant and unloaded in the same manner into storage bins partitioned off for this particular purpose.

The "raw end" of the plant consists of four storage bins below the track level, two 90 ton overhead bins for raw stone, one coal hopper with single roll crusher and

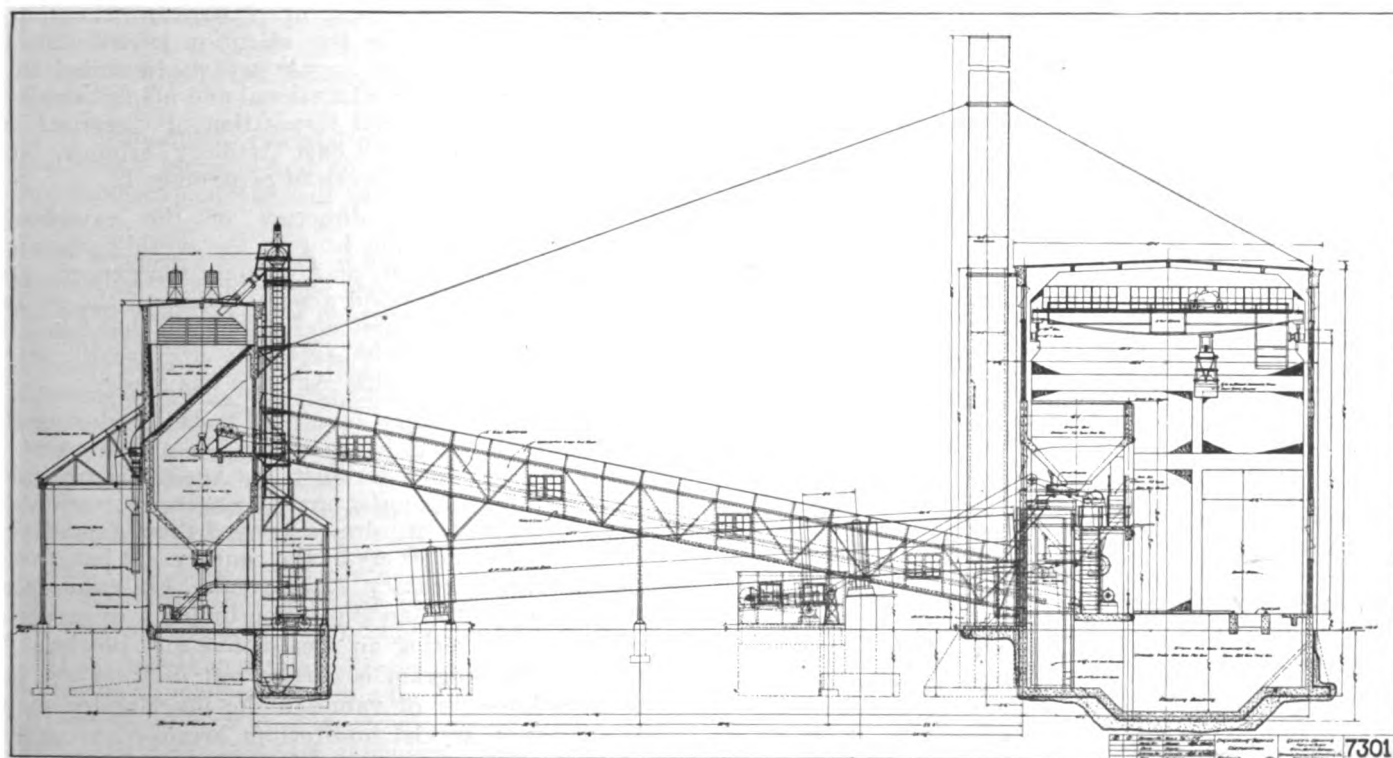


Fig. 1—General layout of new rotary kiln lime burning plant.

apron feeder, plate feeders for regulating supply of lime stone to kilns, crane for handling stone and coal and the necessary building to house this equipment.

There is approximately 1,500 tons total capacity in the storage bins below the track level of which 800 tons is for stone exclusively, 350 tons for coal and 350 tons for either stone or coal as conditions may require. Bituminous coal having a very low sulphur content is used. After being received at the "raw end" of the plant and passing through the crusher, this coal is conveyed to the "finished end" of the plant by means of an inclined belt conveyor and a scraper conveyor which distributes the coal to two overhead storage bunkers. At this point coal is fed directly to pulverizers which pulverize and deliver the coal to the kilns in one operation supplying at the same time the proper amount of air for combustion.

The coal conveying and crushing equipment is motor driven and automatic compensators are used in order to secure the advantage of interlocking control. This control is arranged in such a way that the conveying equipment cannot be started or operated except in the proper sequence which obviates the possibility of piling up coal at some intermediate point due to failure of any one unit in the whole conveying equipment. The interlock is so arranged that the scraper which distributes crushed coal to the storage bins over the pulverizer is the first unit to be placed in operation, this being followed by the belt conveyor; the crusher being the last unit to go into operation. Should the power supply to either the scraper or the belt conveyor be interrupted, the crusher will be automatically closed down.

By the use of the pulverizer selected for this installation, the cost of coal plant is reduced to a comparatively low figure as compared to the conventional coal pulverizing and preparation plant consisting of dryers and grinding equipment. Since at a later date this plant will in all probability be changed over for operation on gas as fuel, it was advisable to hold the investment in coal pulverizing plant as low as possible. Very satisfactory results have been secured however with this equipment, the only difficulty which has been experienced being when an unusual amount of moisture was present in the coal, which increases the power consumption of the pulverizers very materially.

While two kilns are installed, one is sufficient to provide for normal operation of the present open hearth furnaces, since one kiln has a capacity of 60 to 65 tons of finished lime per 24 hours. With the second kiln as a stand-by and the large storage capacity, ample assurance is provided for a continuous supply of lime.

At the "finishing end" of the plant, storage has been provided for 130 tons of coal and 185 tons burnt lime, this storage all being arranged for gravity discharge to the pulverizers in the one case and to open hearth charging boxes or to standard car in the other case. Both standard gauge and industrial tracks are served by the lime storage, the finished lime being loaded directly into charging boxes on the industrial track and delivered to open hearth furnaces. In normal operation this permits of charging lime before it has completely cooled, thus giving the open hearth furnace some little advantage of the heat required for burning the lime.

Motors on kilns, pulverizers and conveying equipment are 440 volt, three phase, 60 cycle induction motors and power is supplied for these motors from the mixed pressure turbine plant, which was also designed and erected

by the Engineering Service Corporation. Kiln motors and pulverizer motors are variable speed slip-ring type and are controlled from firing floor as are all motors for conveying and elevating equipment.

The crane is equipped with direct current motors and current is supplied by motor generators in the turbine plant. Direct current is also supplied to magnet for collecting tramp iron which may be present in the coal. One of the outstanding features of the plant is the liberal dust separating chamber between the rotary kiln and the stack. Very efficient dust separation is obtained, practically no dust escaping from the stack. This is an important feature and one which is being given a great deal more consideration at the present time than has been the case in former years, not only from the standpoint of cleanliness, but for the recovery of valuable by-products. This dust chamber is arranged for convenient cleaning and the dust may be handled by the crane bucket directly into a standard car. The kilns are served by individual stacks 6 feet inside diameter by 90 feet in height. Provision has been made for extending the plant at some future time, reinforcing steel and connections being left at the proper points for this purpose. After changes are made for operation on gas, which is now available, commercial lime may be produced in addition to supplying the requirements of the open hearth furnaces.

This plant was designed by the Engineering Service Corporation of St. Louis and the entire construction was also under their supervision.

CHEMICAL EXPOSITION SEPTEMBER 12-17

In a most impressive array, the remarkable and spectacular achievements of American chemistry, brought so forcibly to the attention of all nations during the World War, again will be unrolled in a panorama of practical, educational and helpful exhibits at the Seventh National Exposition of Chemical Industries at the Eighth Coast Artillery Armory, New York City, during the week of September 12.

According to the directors of the exposition, America has taken the lead in the world's chemical industry since the war, and not only the experts, students, manufacturers and general public of the States, but foreign nations, particularly the ones that formerly did a big business with Germany are greatly interested in the progress that America has made.

The growth of the Chemical Exposition during the last seven years has been a barometer of the trend of public thought and interest in America's scientific achievements. Manufacturers, engineers, scientific men and students are drawn toward these remarkable displays from all corners of the country. It has, therefore, become necessary to stage the 400 exhibits of this year's event in an exposition building of immense proportions, covering an area of five city blocks. As much of the program is carried out in speeches, lectures, and papers of value to the investigator along these lines, a special auditorium arranged according to the plan of a theater, and having a seating capacity equal to many such houses, will meet the needs of a quiet and comfortable lecture hall. It will offer an ideal place for the many symposiums that will be held during the week.

Discussion on Open Hearth Practice

Some Facts and Data Pertaining to Combustion Efficiency in an Open Hearth Furnace — Open Hearths of Today Have Not Shown Their True Ability.

By HENRY WILLIAM SELDON, B.S., Met. Eng.,
See-Seldon and Associates, Engineers.

STARTING with the fundamental parts of an open hearth furnace we elaborate or modify our furnace construction in order to make steel more quickly, or to reduce the heat losses, or to increase the furnace life. In other words we change the construction of our furnace to attain some specified object more efficiently. The first and most essential component upon which we find the successful operation of an open hearth furnace depends is primarily one of securing efficient combustion.

In order to obtain more efficient combustion after we adopt a reverberatory type of furnace, is to use checker brick to absorb and recover some of the waste heat. We do this because knowledge and experience has proven that the speed and temperature of combustion is increased by pre-heating of the air (and producer gas).

Likewise we know or should have determined by past experience the best size and location of gas and air ports necessary to supply the requisite amount of gas and air at a velocity best suited to the furnace requirements. We provide a stack damper to regulate the draft on the furnace in order that we obtain all the heat possible from our burnt gases and also to provide additional draft as the age of the furnace increases and the flue passages become smaller. Should we find the temperature of our gas or air chambers do not correspond, or the draft is not evenly distributed we have provided individual flue dampers which can be regulated to correct such a condition.

It is absolutely essential the various valves and seals shall work properly and be free from leaks, otherwise our balanced machine will be hopelessly out of running order.

It becomes evident when we get down to elementary reasons and principles that checkers are installed to pick up waste heat from the burnt gases. The number and method of construction can be anything which will supply sufficient heat, (obtained from the waste gases), to the incoming gases without interfering with the passage of the gases in either direction. Likewise the efficiency of our furnace increases as the temperature of our incoming gas and air is increased. Provided our furnace has sufficient draft and our incoming gas and air is being sufficiently pre-heated we can forget about our checkers.

After we have found the best type and method of construction and have built our furnace accordingly still we find a variation in the working qualities.

If we would maintain uniform results it is desirable to provide all manner of means for adjusting the various portions of equipment in order to correct faulty conditions. In this case an intelligent and experienced operator will use the means of adjustment which are provided and the result is the faulty working will be overcome.

The point aimed at in this discussion is to try to show that the difference between a furnace working satisfac-

torily and one working otherwise is one of efficiency and in the majority of the open hearths it is primarily one of efficiency of combustion.

The operating furnace is continually undergoing changes by virtue of the unavoidable wearing down at some points and the building up of others. The result in some cases is we find the furnace works better as it gets older; in many others we find it is getting worse. In the latter case experience will locate the cause but its correction will depend upon the means of adjustment available and the cause of the trouble.

In many open hearth furnaces the amount of fuel used is excessive and could be reduced if the first helpers could regulate their fuel and air intelligently and to suit the furnace requirements.

If we are to increase our tonnage in such a shop it will absolutely be necessary to have the furnace work sharply and this can be done *continuously* by constant regulation of the fuel and air mixture.

Due to the construction of some furnaces it is possible to operate with practically no air being taken through the air checkers. This is possible because air is drawn in through the various openings of the furnace and is the reason why the first helpers have formed the opinion it is unnecessary to regulate the air. As further evidence that the first helpers and melters need instruction on burning their fuel we cite the fact that during one entire week the hydraulic line operating the air inlet valves was frozen on several furnaces, and the furnace operators never knew their air valves did not work.

By the utilization of the pre-heated air obtained from the air checkers and by making a more suitable gas it is possible in many cases to speed up a furnace. This is entirely dependent that the first helper regulate with intelligence the gas and air mixture. A very striking illustration of the valve of regulating gas and air is shown by the ordinary Welsbach gas mantle used for lighting purposes with natural gas. The effect on the lighting qualities is instantly shown by increasing either the air or gas supply independently. Since the lighting qualities of the gas mantle depend upon the combustion efficiency of the gas and air mixture we see at once that it is just as bad to have too much gas in our mixture as it is to have too much air.

We are satisfied that this condition of too much fuel for the supply of air is common in open hearths. For example the practice is to set the air valve by chance to suit an average or supposed average of gas and seldom change the air supply. The result being the furnace works slower, does not require such constant watching and in general puts all blame for any variation in the working of the furnace on the gas house. It is asking the gas maker to send over just the right amount and quality of gas to suit the amount of air on the furnace when the gas maker's conditions are quite variable and he usually has no means of telling the requirement of the furnace.

Better combustion will increase the tonnage of the furnace, increase the life of the furnace and eliminate considerable of the present checker troubles by reducing the volume of the gases to be handled.

Use the correct amount of air, use pre-heated air, use the stack damper to utilize the heat from the various volumes of gas burned and the furnace will produce increased tonnage with a lower fuel consumption.

The progressive manager is well aware of the inefficiency of an open hearth furnace and basing his opinion on past performances is inclined to reason that radical changes must be made in design before they will

be overcome. The lingering doubt in his mind is caused by the recollection of some particularly fine furnace which for a short time had worked so well for him. Also the sad fact remains that of two furnaces built after the same design one will make heats in eight (8) to twelve (12) hours while the other will take from fourteen (14) to twenty-four (24) hours. Every superintendent has his reason but only one can be correct.

Without fear of disapproval and in light of our experience we assert that the open hearth furnace as built to-day has not been forced to show its true ability and that the present tonnage records are poor examples of what can be accomplished.

Lubrication of Gears and Pinions

**One of the Important Problems for the Steel Mill Master Mechanic
Is the Proper Lubrication of Steel Mill Drives — Some Pointers
On How to Properly Lubricate Certain Parts of the Drive.**

By W. F. OSBORNE,
Engineer, The Texas Company.

EVER since the beginning of the iron and steel industry gears and pinions have been used in large numbers for transmitting power. Steel rolling mills in particular necessarily use pinions for driving the rolls at the proper speeds. The drive is positive, convenient, occupies small space and is relatively inexpensive as compared with the cost of other drives.

The principal objection to the gear drive has been the high frictional losses which amount to a very large proportion of the total frictional losses of the entire mill, and increase much more rapidly with increased loads than do the losses within the bearings. Another serious objection has been the rapid wear and the cost of frequent renewals.

Until recently, within the past ten years, the practice has been to use rough cast pinions and gears, except for the smaller gears such as those of electric cranes which were machine cut. These gears were protected only by such guards and covers as might be necessary to keep the operators from being hurt. Under such conditions the gears were subjected to the most severe service, covered with steel dust and scale flying from the rolls, exposed to heat from the hot metal and frequently soaked with water used for cooling roll necks and pinion bearings.

On account of the construction of these old mills, it is quite impossible to maintain anything like good alignment of gears and pinions so that the pinion necks must be free to move slightly with the irregularities of rotation.

Is it any wonder, with such conditions, that frictional losses are so high?

There are still a very large number of these old mills in operation and a surprisingly high percentage of the new mills have been built without any improvement having been made in gear conditions.

When a new, rough cast gear or pinion is put into service, it should be run dry for a short time to break off the rust and to wear off the worst of the rough spots and moulding sand. If the pinion becomes too hot, a stream of cooling water can be used until the gear teeth

show something like a smooth surface. Then the gear lubricant should be applied direct to the teeth until they are completely coated. Subsequent applications will depend upon local conditions.

If the gears or pinions are enclosed in a tight casing, a sufficient quantity of the lubricant may be introduced so that the lowest teeth will just dip into the lubricant when running. This provides what is called "bath lubrication." When the gear casing is not tight enough to hold a bath of the lubricant, lubrication is secured by direct applications to the gear teeth at frequent intervals, so as to maintain a lubricating film on the teeth. The frequency of applications and the amount required vary with the construction of the mill, the condition of the teeth, the operating service and the kind of lubricant. Some mills have to lubricate gears without bath every eight hours, others only once in twenty-four hours. With the bath system additional lubricant is required only when leakage lowers the level of the lubricant below the lowest gear tooth, or when it becomes necessary to clean the gear case on account of an accumulation of foreign matter.

The bath method has many advantages over the direct application, as it provides continuous lubrication of ample quantity, assuming, of course, that a suitable lubricant is used which will drain back to the bottom of the gear case when splashed against the sides of the gear cases by the gears. The tight casing keeps the greater part of the steel dust and scale off the teeth, increasing the life of the gear lubricant and reducing wear.

Care must be exercised in adding lubricant to the gear case, so that the level of the bath is not too high. Too much lubricant will increase the frictional resistance of the gears passing through the bath, thereby raising the temperature unnecessarily, and reducing the viscosity of the lubricant. It has frequently occurred that the viscosity has been lowered through increased temperatures to the point where the lubricant was no longer heavy enough to prevent wear of the teeth. Only enough lubricant should be supplied to allow the teeth to barely dip when running. Too much lubricant also makes starting in cold weather difficult, blowing fuses on electric

motors, springing shafts and even breaking bearing caps and bolts.

The lubrication of gears and pinions has far reaching effects beyond the frictional losses of the gears, their wear and the cost of replacement. For instance, in a direct coupled mill having several stands driven off one set of pinions, insufficient lubrication of the pinions will cause a hesitating, jerky, rotation of the rolls, accentuated at the end set, resulting in a non-uniform product. As the end stand is usually the finishing set of rolls, it is sometimes driven through a separate set of pinions on this account. An improvement in the lubrication of the pinions will eliminate a great deal of the trouble in securing uniformly finished bars.

For gears on which frequent direct applications must be made, certain characteristics should be possessed by the lubricant.

1. Adhesiveness enough to stick to the gear teeth under the operating conditions of speed and temperature.
2. Enough body (high enough in viscosity) to prevent or reduce metallic contact to a minimum.

3. Sufficient fluidity to spread uniformly over the gear teeth (viscosity of a lubricant can be reduced by heating before making applications. This is the usual practice as all suitable gear lubricants are so viscous at ordinary temperatures that they will not adhere or spread properly unless heated).

4. Remain plastic and retain its lubricating properties under the lowest temperature conditions to which the gears might be exposed.

5. Impervious to hot or cold water which might be splashed onto the gears from the rolls.

The use of the bath system modifies some of these requirements slightly.

1. The lubricant should be fluid enough at all operating temperatures to drain back to the bottom of the gear case to maintain continuous lubrication.

2. It should not be so viscous as to cause excessive frictional losses or high temperatures if the bath level should be carried a little too high.

3. The viscosity should be low enough to permit sediment to settle to the bottom of the gear case, reducing the abrasion of the gear teeth.

The use of machine cut gears and pinions, of the herringbone type has greatly improved the lubricating conditions, as such gears offer a comparatively smooth working surface, reducing frictional losses and making unnecessary the extremely heavy lubricants which are required to cover up the rough spots in the cast gears. If these gears are enclosed in a gear case, providing bath lubrication, the viscosity of the lubricant can be reduced considerably, lowering frictional losses due to the excessive viscosity of the lubricant, without increasing the friction of the teeth by metallic contact.

In designing fully enclosed gear sets of this type, careful attention ought to be given to the design of the bearings to prevent the leakage of the gear lubricant into the bearings, and vice versa. A suitable lubricant for a gear set of this type is so fluid that it is splashed all around the gear case and will run down the sides onto the shafts. Unless suitable stuffing boxes are provided it will work into the bearings, increasing the friction and raising the temperature. In other installations the oil in the bearings may leak into the gear case in sufficient quantities to lower the viscosity of the gear lubricant so that it will no longer lubricate the gears.

An improvement in gear lubrication has recently been made by certain builders, in constructing reduction gears

so that one lubricant can be used throughout for bearings and gears. This eliminates the stuffing boxes between gear bearings and the gear cavity, and there is no longer any necessity for keeping the lubricants separated. It also removes the troubles due to mixing of the lubricants. In order to use one oil for gears and bearings it must be fluid enough to prevent high frictional losses within the bearings and yet sufficiently viscous to withstand the high tooth pressures. In effecting a compromise, the successful gear manufacturer must understand fully the laws of lubrication and the influence of viscosity. As it cannot be expected that every mill master mechanic is going to be an expert on oil, the gear manufacturer ought to determine the correct viscosity oil to use under various operating conditions and advise the mill people what viscosity should be used.

When oil is used as the lubricant it is very desirable to furnish the gears with a pump and spray the oil onto the gear teeth just before they mesh. In this way a positive supply is insured. If the bath system is depended upon, it is highly probable that the air currents induced by the high speed and centrifugal force will throw most of the lubricant away from the teeth and only a very thin film of oil will remain to protect the teeth against wear. If a sufficient quantity of oil is flooded onto the gears, they can be lubricated with a lubricant much less viscous than the usual type of gear lubricant.

From the standpoint of reducing frictional losses, lowering temperatures, and facilitating circulation and separation of sediment, the lowest viscosity oil should be used which will satisfactorily lubricate the gears with a margin of safety to take care of abnormal conditions.

When the viscosity has been selected, the gear bearings should be designed with the proper clearances to allow its use without excessive heating. If oil is supplied to the bearings in a copious stream and clearances are large enough to permit the formation of a perfect oil film, the frictional losses will be reduced to a minimum and will vary directly as the speed, the absolute viscosity of the oil, and inversely as the clearance space between shaft and bearing, all other conditions of design and loading remaining constant. This indicates that if the temperatures are excessive with the use of a viscous oil, they may be lowered by increasing the bearing clearance. In most cases the bearing clearances can be made large enough to prevent high temperatures without at the same time permitting vibration and mis-alignment of the gears. If the speeds, particularly on reduction gear sets of a high ratio, and loading conditions are such that bearing clearances and the viscosity of the oil cannot be satisfactorily adjusted by this method, there is still an alternative.

The viscosity of every oil changes with the temperature, becoming lower as the oil is heated and higher as it is cooled. This property can be used to advantage for gear lubrication when the outfit is large enough to warrant the use of coolers, and heaters in the oiling system. When the force feed spray system is used, the hot oil from the bearings may be allowed to drain into the case. If this warm oil is too viscous for the bearings, a portion of it can be heated sufficiently to reduce its viscosity to that required by the bearing clearances. When an oil having a steep viscosity curve is used, a comparatively slight increase in the temperature will lower the viscosity considerably and although this may raise the bearing temperatures slightly in some cases it will reduce friction and wear. The remainder of the oil which has not been reduced in viscosity can then be supplied to the gears.

New Use of Recording Instruments

Installation of Bristol Recording Instruments at the Blast Furnace of Weirton Steel Company, Weirton, West Virginia, Cause Operating Improvements In Regulation of Furnace.

THIS fine blast furnace plant has a very complete equipment of automatic recording instruments, including recording pressure gauges, vacuum gauges, thermometers, pyrometers, time recorders and tachometers. These instruments are of great service in helping the superintendent and his assistants to get the best possible results. Some of the recording instrument installations are shown in the accompanying illustrations.

The cold blast as it leaves the blowing engines is the first operation to be recorded. The next point is the hot blast pressure just ahead of the bustle pipe. Any excessive discrepancies between these two records of pressure is an immediate indication of trouble.

The top gas pressure is next in order to be recorded; the pipe connection for this is made in the dust catcher. This record gives a good indication of how the stock is working down, and in some cases even gives forewarning of slips. The pressure in the gas main is again recorded on a two-pen instrument; one pen connected before the washer and the other pen after the washer. This record shows any loss in pressure while passing through the washer. In addition to these a record is made of the clean gas pressure at the stoves for the foreman, and the clean gas pressure at the boilers for the boiler operator.

The temperature of the blast and gas is recorded at several points; first at the intake to the blowing engines, because the speed of the engine is varied with the change in temperature of the atmosphere. The hot blast temperature is then recorded, and this point in the process is of such great importance that two pyrometer instruments are connected to one fire-end, one an indicator, the other a recorder. The indicator with the big, easily read scale is installed in the stove tender's shanty and

enables the tender to maintain a uniform heat. The recorder is located in the foreman's office and gives him a continuous record of just what temperatures are held. The fire-end for the hot blast is located in the hot blast main just ahead of the bustle pipe. The top gas temperature is also of great importance, and is to some extent controlled by the skip operator. The indicating instrument for the top gas temperature is in the skip house where the operator can see it at all times, while the recorder is installed in the foreman's office: the fire-end is located in the dust catcher. The temperature of the clean gas is recorded

as it leaves the dryer, so that accurate information as to how much heat is lost in the cleaning process is thus always available. Finally the temperature of the gases of combustion leaving each stove is recorded at the chimney valve. The recorders, one for each stove, are located in the foreman's office and gives him complete information as to how long each stove is on blast and how long on gas. These records also give an indication of the extent to which the checkerbrick is absorbing the heat.

It is very essential that there shall be no lack of water to the bosh, and to insure this a recording pressure gauge is installed on the line. The record made on this instrument shows immediately any faltering of the pumps supplying the water.

The water before and after the washer is recorded on one chart by a two-pen recording thermometer. This supplies valuable information as to the performance of the washer, and the double record of the one chart makes comparison easy.

It is just as important that a blast furnace boiler room operate efficiently, as it is for that of a large generating station, therefore, in the boiler room are a recording steam pressure gauge, for the operator

Fig. 1

Recording instruments in blowers' office, not all of the instruments are shown in the cut. The top row includes recording pyrometers for hot blast and top gas. Below on the second row are the pressure gauges for hot blast pressure and top gas pressure, operation of skip, big and little bells and rotary top, Bosh water pressure, and pressure before washer and after dryer. Continuing in same row, but not shown, are recording pressure gauges for clean gas pressure at stoves, recording thermometers for clean gas temperature leaving dryer, and water temperature before and after washer. The racks show convenient method for filing charts after removing from instrument.

Fig. 2

This shows fire-end installation of pyrometer for measuring temperature of gases of combustion leaving one of the stoves.

Fig. 3

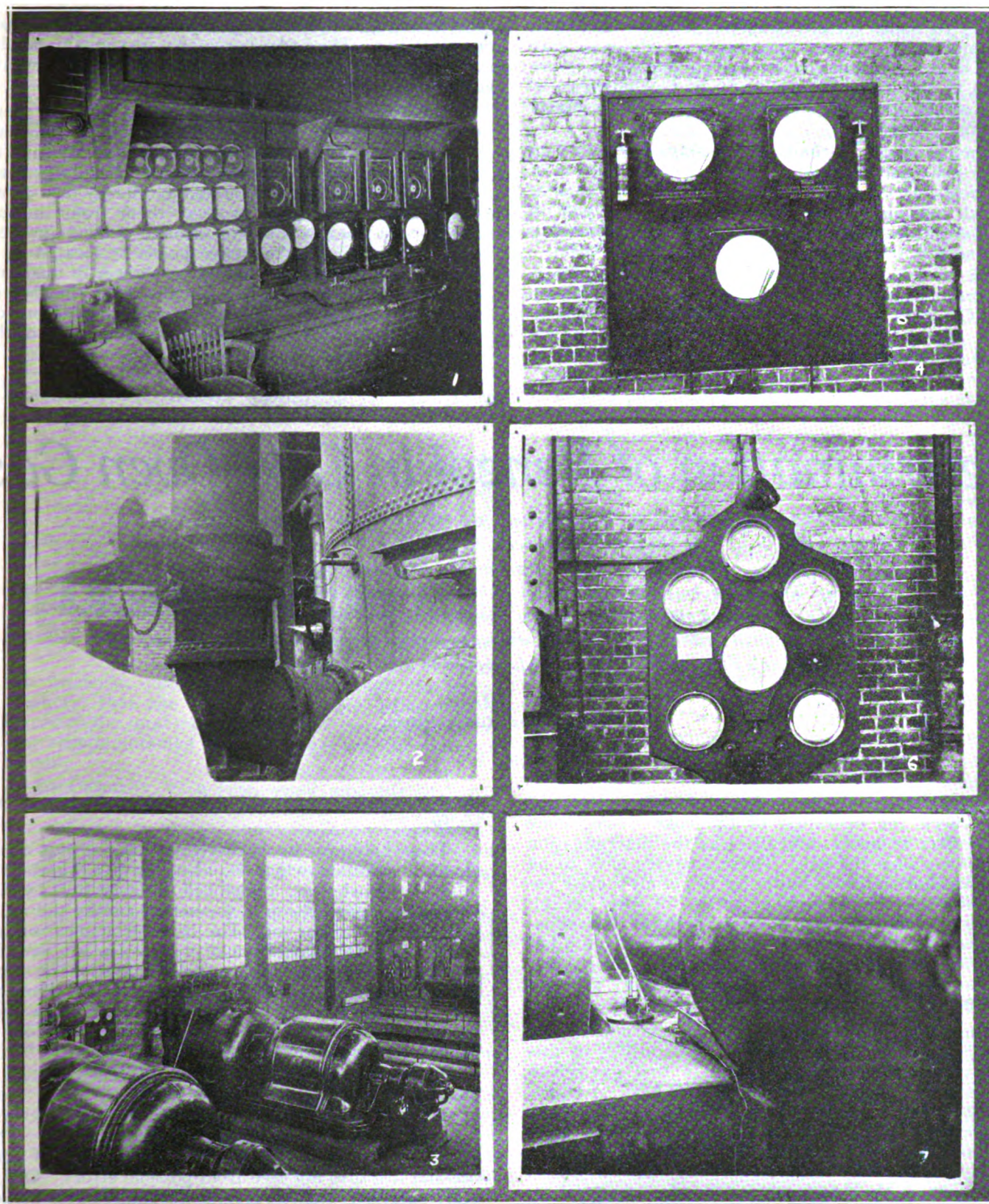
Partial view of power house showing in the foreground two turbo-generators, and on the wall between them are to be seen the condenser vacuum recorder, incoming water pressure recorder, and the three-pen thermometer for the condenser of the right-hand turbine. At the right of the picture is shown part of one of the two horizontal blowing engines. On the wall are the various instruments. The pressure gauge on the pillar is recording cold blast pressure. Next comes the Mesta gaugeboard with a recording tachometer in the center. Beyond that are the vacuum, water pressure, and three-pen temperature recorders for the blowing engine condenser. There is also a recording pressure gauge for steam entering the power house. In addition is the recording thermometer for atmospheric temperatures, and tachometer for second blowing engine. There is only one set of condenser instruments for the two blowing engines, since both engines use the same condenser. This is possible because only one engine runs at a time.

Figs. 4 and 6.

Closeup views of instrument boards in the power house.

Fig. 7

Shows method of connecting tachometer stand to the blowing engine with flat belt drive. The flexible capillary tubing is the lead from the stand to the recording instrument.



must keep his pressure constant; a recording thermometer on the feed water line; and a recording steam temperature thermometer.

In the power house proper are recording pressure gauges to show the pressure of the steam from the boiler house, and the circulating water to the condensers. The condenser temperatures are also recorded; the incoming cold water, the outgoing tail

water, and incoming exhaust steam. For these a three-pen recording thermometer is used, which furnishes the three records on one chart for ready comparison. In addition to this a recording vacuum gauge is installed in connection with each condenser.

As previously stated, the speed of the engines is varied with the atmospheric temperature changes, and a recording tachometer on each engine helps the en-

gineers to make these variations occur at the right time and in the correct increments, as the case may be. The revolving mechanisms of the tachometers are belted to the main driving shafts of the blowing engines which are of the horizontal type built by Mesta Machine Company.

The operations of the bells and skips are shown on a four-pen time recorder. This is done by means of an electrical contact actuated by the counterbalance of each bell and which in turn operates the pen on the instrument. There are also contacts on the skip hoist so that the operation of the cars actuate them.

One of the outstanding features of the very complete recording instrument equipment at the Weirton Steel Company is the interchangeability of the pyrometers. Every pyrometer is calibrated for the same external resistance, and each unit connected direct to

the fire-end, without using any switches or multiple connections. Thus any pyrometer instrument can be used with any set of leads and fire-end with accurate results.

Another feature of the equipment worthy of mention is the fact that an instrument sufficiently sensitive to record the fluctuations in pressure will continue to operate in the dust filled atmosphere. Each recording mechanism, however, is mounted in a husky dust-proof case, which thoroughly protects them from the excessive dirt always abundant around a blast furnace. One instrument in the boiler house is located at a point where occasionally a regular shower of dust and dirt descend upon it. It is a fact that after the shower is over the dirt is generally about an inch deep on top of the instrument, but the case keeps the inside of the instrument entirely free from dust.

Determination of Benzol in Coke-Oven Gas

The following data and explanations will, we believe, prove to be of interest to our readers, because they show European methods for the determination of the benzol in the coke-oven gas. As, in this country, by-product plants are erected in larger numbers every year, and benzol is one of the most valuable by-products. As it is difficult to obtain reliable figures in regard to its content in coke-oven gas, the methods described in the present article as well as in those following will no doubt cause a comparison of the methods applied in the U. S. with those of Europe

By A. THAU,
Chief Engineer—Gesenkirchen.

PART I.

OF all the analyses to be made to control and check the operation of the coke ovens, none offers as many difficulties as the determination of the benzol in the gas. These analyses have to be made in short intervals, in order to permit a close supervision of the absorbing action of the benzol-washers. The difficulty in making these determinations can be seen in the fact, that, while all the other chemical investigations to be made in a coke plant, are standardized, the benzol is found in many different ways, as will be proven in the following.

The difficulty connected with the determination of benzol is mainly due to the small quantities of this constituent in the gas, especially in that gas which has passed through the benzol-washers. Besides, benzol is very inactive, and, for this reason, it can not be used in the same way as most of the other gas constituents, for instance, carbon dioxide, ammonia, sulphur, cyanogen, etc., the amounts of which, on account of their high affinity to other chemical reagents, can easily and exactly be determined.

In actual operation the washing process, as far as ammonia, sulphur, cyanogen and recently ethylene are concerned, is based on chemical reactions, whereby a chemical affinity between the washing liquid and the gas constituent considerably facilitates the absorption. These conditions are not given when benzol is to be absorbed. It is true, benzol vapor will be dissolved

by the wash-oil, but it will not combine with it chemically.

The whole process is, therefore, nothing but a mechanical solution, which is, along with a number of other circumstances, influenced unfavorably by the very high vapor tension of the benzol and by the moisture contents of the oil. The basic principles, underlying an efficient operation of a benzol plant, are, for this reason, the largest possible diminution of these influences, by drying the gas, and by a low temperature and good quality of the wash-oil. If these principles are not strictly observed, the correctness of the benzol determination must be questioned.

The few operations to determine chemically the quantity of benzol in the gas, have not given satisfactory results. Some investigators (Harbeck and Lunge) determine the benzol as dinitrobenzol. This operation is, however, too complicated for general practice and it is also not free from possible errors. Others (Deenis and O'Neill) recommend ammoniacal nickel-cyanide as a good absorber, but this reagent also dissolves ethylene, thus giving incorrect results.

All these methods have been examined and investigated very carefully, and it has been found that they are valueless for practical determinations. It has been pointed out, that no matter how desirable a volumetric determination would be, on account of its quickness and simplicity, such a procedure is very unreliable because the contraction in volume after absorption is so

From "Gluekauf," May 28, 1921.

small that it can hardly be noticed. This contraction amounts to only .09 ccm for 3 g of benzol; it is, therefore, hardly visible in the ordinary gas burettes. Even with the instruments for making mine gas analyses, which have a very fine graduation, reliable results could not be obtained when using nickelcyanide.

The ways and means generally employed when making gas analyses, can be divided into groups, in the volumetric group, in which the contraction after absorption is measured of a certain previously determined quantity of gas, and into a group, which permits the passing of the gas through an absorbing agent, in which the gas constituent wanted is determined in different ways.

When making a volumetric determination, which, when executed carefully, gives very good results, the heavy hydrocarbons benzol and ethylene are determined by absorption in fuming sulphuric acid or in bromine water. But the quantity of gas used for the analysis, mostly 100 ccm, is so small in relation to

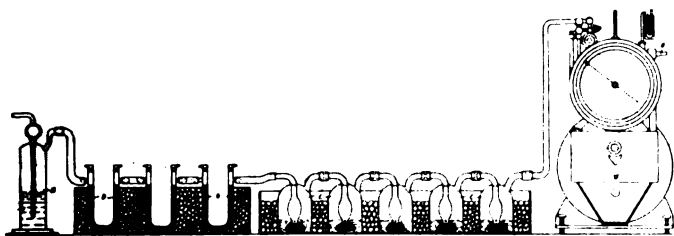


Fig. 1—Complete benzol absorption train after Boennemann.

the immense quantities passing through the benzol washers, that the least unnoticeable difference, referred to the total gas quantity, will cause large errors. The results obtained in this manner are, therefore, unreliable.

In Germany, as a rule, small amounts of benzol are absorbed and then determined by weighing them out, whereas in foreign countries large quantities are absorbed, and then distilled out of the absorber and measured. The first-named procedures will be dealt with first in the following.

Especially in those cases, where larger quantities of benzol have to be absorbed, gas wash bottles are employed, which may have different forms and shapes to suit personal ideas. They will not be described below, but only that apparatus will be illustrated which serves exclusively for the benzol determination.

Determination by Weighing of the Benzol—Paraffin-Oil Process.

Since the weighing of ordinary gas wash bottles requires chemical balances of comparatively high capacity combined with sufficient sensitiveness, and since the surfaces and the ground part of the bottles may easily give rise to mistakes, simple potassium tubes are employed for these determinations. The tubes must be provided on both sides with bulbs; on the entering side in order to prevent the aspiration of the contents in case there is a slight draft in the apparatus, and on the other side to prevent the gas from carrying the absorbing liquid away.

The best absorbing agent for benzol is fresh wash-oil, which does not precipitate solid particles when cold, and which, even at a low temperature, remains comparatively easy flowing. Principally used in Germany for this purpose is the clear paraffin oil. Care

must be taken when using this oil, because some grades become lighter when air or gas is passed through them, thus showing a content of volatile constituents. It is safest to heat the oil slowly to its boiling point before using in order to drive out the volatile matter.

The tubes are charged with this oil in such a way that the three bottles are half filled. Up to six of these tubes are weighed, after having been charged; they are then put together with their ends so that they touch each other, thus eliminating as much as possible the use of rubber tubing, which also absorbs benzol. The tubes are then placed in a large tin box and surrounded entirely with small pieces of ice. The total arrangement is about the same as that of Boennemann described below and illustrated in Fig. 1.

The gas must pass through the apparatus so slow that the different gas bubbles become visible separately and independent of each other in the different bulbs as they pass through the oil. For investigations which require great correctness, a flask holding between 15 and 20 cubic feet and filled with water is used in place of the gas meter. This flask acts as an aspirator, and forces, by means of a syphon, the gas through the apparatus. The quantity of water flowing out of the syphon being measured, it corresponds to the amount of gas aspirated. When determining the total contents of benzol in the gas before it enters the benzol washers, generally 20 to 25 cubic feet are aspirated in between 3 and 4 hours. If the rest of benzol, which remains in the gas after it has passed through the washers, is to be determined, a double quantity of gas is used. After the absorption is finished, the tubes are removed from the ice bath and carefully wiped dry. The gas above the oil is displaced by air and the tubes with their contents are weighed, after they have obtained room temperature. The increase in weight corresponds to the benzol contents in the measured gas quantity. Corrections must be made according to temperature and atmospheric pressure, which must be observed during absorption.

This method has, under the name "paraffin oil method," found a large distribution and many adherents. In the hands of an experienced analyst it gives very good and reliable results, however, there is room for improvements. That part needing improvements the most appears to be the tube proper, which, on account of the numerous uneven surface parts, caused errors in weighing, besides being very fragile. Furthermore, oil can easily be carried out with the gas, even if there are bulbs provided to prevent it.

These objections have been taken care of in the absorption apparatus. The three burettes of the original potassium tube have their original size and shape and they are suspended in a small cylindrical bottle, which is hermetically closed up and provided with a gas outlet tube bent in a right angle. The gas entering tube has a bulb and is rigidly connected with the burettes, being molten into the cover of the bottle, in which the burettes are suspended. The gas outlet tube, which is molten into the cover of the bottle, has no connection with the burettes. The burette from which the gas last leaves, is provided with a thin tube bent downward, through which the gas first enters the bottle, i. e., the space around the burettes before it leaves through the outlet tube. In this way the oil eventually carried along by the gas is retained on the bottom of the apparatus, thus preventing sources of error on account of oil losses. These wash bottles have the advantage, that, on account of their

uniform surfaces and their smaller chance for breaking, they can easily be cleaned and dried.

Determination of Benzol, Boennemann's Method.

Similar to the last named apparatus, the benzol absorption bottle of Dr. Boennemann has also even, easily cleaned surfaces on the outside. This advantage is combined with comparatively large diameters of the connecting tubes.

When a determination of benzol is to be made, 5 or 6 of these bottles, filled with oil, are connected in a row, as shown in Fig. 1. The gas passes through as short a tube as possible and enters into the wash bottle "a," containing picric acid, which retains the naphthalene. It then flows through the calcium chloride tubes "b," standing in a box filled with ice, from where it leaves in a completely dried state. The gas passes into the atmosphere, either directly, or by means of an ejector driven by steam or water. The latter arrangement is applied when the gas pressure is too low to overcome the resistances in the apparatus.

Benzol Determination According to Krieger.

During his investigations into the determination of benzol, Dr. ing. Krieger has found that, when gas passes through the oil-filled absorption bottles, oil is almost always carried away with the gas, a condition which naturally influences the correctness of the final results and which, from the start, requires the use of a larger number of bottles than would otherwise be necessary. In order to prevent this, he has tried a number of differently shaped bottles, finally deciding upon a wash bottle, which is formed after the well-known type of Drehschmidt's. This wash bottle is about 22 cm high with a diameter of about 5 cm. The gas outlet connection is not simply connected to or molten into the cover, but in the inside it reaches into a compartment, which has the form of a test tube of 1.2 cm inside diameter and 15 cm in length. In the center of the bottom of this test tube there is a small opening, and about 1.5 cm above this opening there are a number of small holes; through these holes and through the opening, the gas, leaving the apparatus, enters the compartment, which is filled with glass beads of about 2 mm diameter. On the top the compartment is closed by a stopper, through which the gas outlet enters. When the gas passes through the bottle, which is filled with oil up to the mark shown in Fig. 5, the benzol is absorbed in the lower part; the oil, carried away with the gas, is held back by the glass beads in the tube. After a few determinations have been made, the oil collects on the bottom of the compartment and drops through the opening in the center of the bottom back into the absorption bottle. After this has happened, the compartment, before starting a new determination, is washed out with benzol and dried carefully.

According to statements made by Dr. ing. Krieger and verified by the writer, two of these bottles are sufficient to absorb all the benzol. During operation the bottles are standing in an ice bath and they must attain room temperature again, before they can be weighed. Besides, the air contained in the bottles must be replaced by dried gas. But since, after absorption, the gas diffuses out, without replacing the air entirely, the bottles are connected after absorption to a gas line in the laboratory, during which time the gas outlet is closed by suitable means (rubber tube and pinch cock). After room temperature is

reached, the rubber tubing is taken off, the bottles wiped off carefully and weighed. If these things are not carefully watched, errors in the bottles can easily happen, which make the analyses worthless. It must, however, be said that cork stoppers have, according to the writer's experience, not given satisfactory service, because the porous cork shows a continuously varying contents of moisture, which influences the results considerably. Only after rubber stoppers had been employed, which had a coat of waterglass on the bottom, to prevent the gas from coming in contact with the rubber, have satisfactory results been obtained.

(To be continued)

LUBRICATION OF ROLLING MILL PLANT

In an article by F. Linzen, which recently appeared in *Stahl und Eisen*, the following appeared:

The author writes as the result of a lengthy experience of the running of rolling mill plant. As regards the lubrication of rolling mill engines, this offers no difficulties, the central forced system being probably the best, as in addition to thorough working safety it has the advantage that the oil can be admitted liberally without fear of waste. In one works to which the writer refers there is a central "oil-treating" system, which collects all the dirty oil from the various machines and pumps cleaned or fresh oil. In this method, the oil is never touched by hand at all. Every machine has a clean and a dirty oil pipe to and from the central plant, and a signalling device. All the dirty oil from the machines runs into a tank, being pumped thence to the central station. The oil passes through a graduated measuring vessel before being pumped to its destination.

As regards lubrication of the gearing, all kinds of grease had been tried and have been abandoned in favor of oil, as the wear of the working parts was very considerable with grease lubrication. All the pinion bearings are lubricated with oil, and the pinions themselves with grease rendered less viscous by the addition of oil. In the mills he is referring to, the bearings of the slow-running ingot trains are fitted with wick lubricators, and the large finish mills with ring lubricators. In the smaller mill trains, i. e., from about 22 inches downwards, the following system of lubrication has proved satisfactory: On the housing of the pinions is an oil tank, which distributes fresh or cleaned oil to every ring-lubricated bearing, the flow being capable of regulation. The pinions are separately lubricated on the overhead flow system, oil being sucked up from the closed casing by a geared pump driven from the pinion spindle and then allowed to splash from the top on to the pinions, so that the oil is continually circulating during the rolling operation. The gear-wheels of the continuous mill-trains are lubricated in the same way as the pinions, the circulation being continuous in this case also and driven by geared pumps.

Oil lubrication, where feasible, in place of grease lubrication, necessitates less attention, and, as mentioned above, reduces wear. A comparison of the two systems of lubrication at the writer's works showed that a grease-lubricated 240 mm diameter bearing, 400 m long, which had been running for three years, revealed a wear in the bearings of 4 mm and of 2.9 mm at the journal; whereas, with oil, the bearing wear was only 1.2 mm, and the journal wear 0.2 mm after three years' running at a speed of 120 rpm.

The Logic of Roll Design

Discussion on Particular Features of Roll Design Such as the Determination of the Maximum Draft on Each Pass and the Determination of the Minimum Diameter of the Rolls.

By W. H. MELANEY.

PART IV.

THE writer has been requested to answer the following questions on roll design:

1. With a given ingot to be reduced to a bloom in a given number of passes, how to determine the maximum draft on each pass?

2. How to determine the minimum diameter of rolls either with two or three high mills, and whether or not there is a stated formulae for this work.

In answer to 1, the writer wishes to state that in his judgment the maximum draft that should be used at a pass, is that which will permit the ingot to enter the rolls without ragging or knurling the rolls. For no matter how carefully this ragging or knurling is done the effect on the surface of the steel is deleterious, although in some instances it is permissible.

For instance, in very soft steels that can be finished at a fairly high heat, this ragging permits greater speed in rolling, because the draft can be increased per pass, or the rolls can be run at a greater number of revolutions per minute and still permit the steel to enter easily. If the ragging is correctly done by using a blunt knurling tool, the marks left thereby will usually roll out on the softer grades of steel under future reductions without visible injury to the finished bar.

But on hard steels such as tool steel, whether the hardness is due to carbon or alloy, the practice of ragging should never be resorted to. One reason why rolls for rolling hard steels have much lighter draft than those for softer steels is due to the fact that the bar offers greater resistance in entering the rolls, and either the draft or the speed of the rolls must be reduced in order to permit it to enter without ragging. In the case of hard steels the effect of the ragging would be carried through to the finished bar, showing a seamed or cracked surface when magnified.

As stated in a previous article, the usual method of determining the maximum draft on soft steels for any diameter of roll is that shown in the accompanying illustration where the angle of contact does not exceed 30 degrees as shown. This will require no ragging, but on hard steels this draft must be reduced in proportion to the hardness and the decrease of heat at which this steel must be rolled, and usually represents a reduction in draft 50 per cent less than softer steels.

So far as the writer knows there is no hard and fast rule governing this process, and considerable judgment must be used in determining all the conditions that exist in every special case. However, the above specifications will successfully take care of general conditions.

It will be noticed that rolls as usually designed do not reduce the ingot at a given percentage of decrease of area at each pass, and this is due to the fact that particular sizes of billets are required to be produced in the usual run and this may require a greater or less draft to be used on a second or third pass than was used on the first.

While it is entirely practical to reduce a given size of ingot by using the maximum draft for that portionate reduction for each pass all the way down, this is rarely, if ever, done in practice, and could only be used where a given ingot was to be reduced to a given size of bloom in the least possible number of passes, irrespective of any other consideration and even then the conditions would be more or less modified by the quality of the steel and the temperature at which it was rolled.

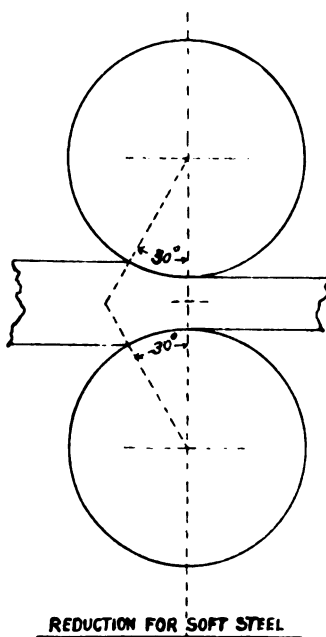
The softer steels which will stand a good soft heat in rolling being susceptible to greater abuse from excess draft obtained by ragging the working surface of the rolls, which would permit of an increased draft in some instances of 25 per cent.

The conditions cited above apply only to the reduction of an ingot in open passes, as in all other forms of rolling in enclosed grooves the draft will be contingent upon the shape of the groove, the amount of slabbing action that can be produced in the groove, and its capacity to take care of overfill without objectional finning.

How to Determine the Minimum Diameter of Roll to Successfully Reduce a Given Sized Ingot.

We will first consider this question based on the use of three high rolls as the assumption is that these rolls would be fixed in a stated position on the center line and, therefore, form a set of positive grooves, with a given reduction on each pass, and susceptible of very slight adjustment, therefore the groove would have to be cut into each roll to a depth sufficient to admit the ingot or bloom with the amount of draft previously decided upon.

Then the size of ingot to be rolled and the groove in these rolls having the smallest diameter and which is usually the first groove, will determine the proper diameter of roll to be used for this purpose (assuming commercial sized ingots are to be rolled). As the deep groove in this case would be on the end of the roll near the neck bearing, and if it becomes necessary to have two such deep grooves, which sometimes happens, then the second deep groove, if practical, is placed at the other end of the roll near the other neck



bearing, thus permitting the grooves in the center of the roll to be larger in diameter, making a stiffer and stronger roll than would result if the deep grooves were placed farther away from the neck bearings.

Under conditions as outlined above, the minimum diameter of the deepest groove should not be less than the diameter of the neck of the roll, and in usual practice should exceed this diameter by at least 10 per cent.

This same rule would apply to two high mills if both rolls were fixed at the center line with no adjustment of the top roll. The conditions then would be the same as on the three high mills.

On two high mills with a top roll that can be raised or lowered, such, for instance, as a reversing blooming mill, and which is the most desirable method of reducing an ingot, this rule does not apply.

In rolls of this type it is only necessary to have a groove deep enough to properly hold up the ingot or bloom and prevent it from assuming a position that would cause the top and bottom of the ingot to become out of square with its side. If this should happen it is extremely difficult to square it up again without employing some exterior means of holding the ingot up, until the faces have been brought back to a right-angle turn. If this condition were permitted to go on, the bloom would finally turn over in rolling. On the ordinary blooming mill roll these grooves will vary in depth from 3 inches deep on the larger grooves to $1\frac{3}{4}$ inches deep on a groove for rolling a 4-inch billet. The top roll being raised sufficient to admit the larger size of ingot and then lowered on the succeeding passes to produce the size of bloom or slab desired. Mills of this type usually range from 30 inches diameter by 70 inches long to 45 inches diameter and 96 inches long, the two more popular sizes being 35-inch and 40-inch mills.

While so far as the writer knows there has never been any formulae or rule definitely accepted for determining the size of neck for any given diameter of roll, successful rolling mill practice has demonstrated that certain standards have been pretty closely adhered to in determining this question and have produced very satisfactory results.

However, due to the radical difference in conditions that exist in the various types of rolling, it has been found necessary to separate them into four distinct classes.

Class 1. Guide mill, bar mill and structural mill rolls in all of which the roll necks are kept drenched with water during the rolling process and, therefore, prevented from heating so that they run practically cold and are easily kept lubricated. Therefore a smaller diameter of neck may be used advantageously.

Good practice has shown that on mills of this type rolls from 7 inches diameter up to and including 16 inches diameter should have necks of a diameter equal to five-eighths the pitch diameter of the roll, or pitch diameter $\times 0.625 =$ diameter of the neck. And above 16 inches diameter of roll the neck should have a diameter equal to two-thirds the pitch diameter of the roll, or pitch diameter $\times 0.67 =$ diameter of the neck.

Class 2. Plate mills which produce wide plates of various thickness, usually from $\frac{3}{16}$ inches thick and over, and are, therefore, subjected to greater strain than bar mills, but the necks of which can also be kept drenched with water so that they run comparatively cool.

In mills of this type the neck should have a diameter equal to three-fourths the pitch diameter of the roll, or pitch diameter of roll $\times 0.75 =$ diameter of the neck.

Class 3. Sheet and tin mills which are called upon to produce wide sheets of light gauge and which, due to the nature of their product, must be run hot, and as there are usually a number of these mills connected in a straight line to the same drive and must withstand not only the rolling strain, but severe shock from back lash, together with the difficulty of keeping these hot necks properly lubricated, and the fact that the roll next to the drive must transmit all the power for the other stands connected to it, practice has demonstrated that the neck on this type of roll should be eight-tenths the pitch diameter of the roll, or pitch diameter $\times 0.8 =$ diameter of neck.

Class 4. Reversing blooming mills used for reducing ingots to blooms and which can be run under more favorable conditions than any of the other types, having only one piece of steel in the rolls at any one time, and this can be kept with little difficulty at a good hot rolling temperature. Therefore, the necks do not have to be so large in diameter as either of the other types, as they are easily kept lubricated.

General practice has shown that nine-sixteenths the pitch diameter of the roll gives a very satisfactory diameter of neck for this type of roll, or pitch diameter $\times 0.5625 =$ diameter of the neck.

These formulae have been based upon prevailing sizes of necks in common use at mills considered to have good practice and the size of these necks were generally determined by the cut and try method by increasing the size of neck until a diameter was arrived at, that would stay in the game on that particular class of work, without serious trouble or breakage.

Therefore, they have the redeeming virtue of having been proven out in practice.

A roughly approximate rule for determining the pitch diameter of a three-high mill with positive grooves, suitable to reduce a given size of square ingot or bloom is $2\frac{1}{2}$ times the thickness of bloom equals the pitch diameter of the mill required.

In the next article the proportion of wabblers to the size of neck for the various types of mills, will be considered.

THREE CHARCOAL FURNACE PROJECTS UNDER WAY

In addition to the plan considered by the Ford Motor Company for building a charcoal blast furnace near Negaunee, Mich., two other charcoal furnaces are contemplated by other interests, according to Skilling Mining Review, of Duluth. The proposed sites are on the Menominee iron range. The Mining Review states:

"One of these projects is in the hands of M. E. Richards, formerly in charge of the Judson mine, and earlier than that interested in Mesabi range properties. Associated with him are some hardwood lumber manufacturers, and the plan is to secure money for the erection of a furnace of approximately 100 tons capacity."

The other project, according to the Mining Review, is that of Iron Mountain interests who hope to connect a blast furnace with ore deposits adjoining the Chapin mine.

Modern Drop Forge Plant Completed

The Pittsburgh Knife and Forge Company's New Plant at Coraopolis, Pa., Incorporates Latest Ideas In Design for Production of Special Parts — Complete Plant Layout Given.

By E. C. COOK.

IT is common knowledge that the drop forging industry has grown at an amazing rate during the past few years. Several figures recently published by the United States Department of Commerce in the Census of Manufacturers will emphasize this point better than any other statement or series of statements which the author might make. Their report reads as follows:

	Number of Establishments	
	1919	1914
Iron and steel forgings not made in steel works or rolling mills..	240	191
	—Value of Products—	
	1919	1914
Iron and steel forgings not made in steel works or rolling mills..	\$171,676,000	\$28,961,000

From these figures we see that in the past five years the number of forge shops has increased about 25 per cent. This might be considered a rather small increase, but when the value of the product is considered, the matter appears in quite a different light. From approximately \$29,000,000 in 1914 to \$172,000,000 is quite an increase. In fact, if we stop to figure it out, it will amount to about 600 per cent. The question is naturally asked: What is the reason for this enormous increase in the production of forgings? Those familiar with drop forgings will immediately say the automobile. This statement is very largely true, for it is primarily due to the increased use of automobiles that drop forgings have gained such prominence.

The statement which was made in a recent issue that drop forgings have been bought and not sold is too true. Every manufacturer who was in position to make drop forgings had orders thrust upon him, and the industry prospered amazingly. The demand was such that a great number of new plants were built. One of the very newest of these plants—in fact it is scarcely completed at this time—is that of the Pittsburgh Knife & Forge Co. at Coraopolis, Pa. Formerly located on the banks

of the Ohio river in Lower Allegheny, this company found itself cramped for room. With little chance to acquire additional property, and that property so expensive as to make its purchase a very questionable move, the Pittsburgh Knife & Forge Co., as so many other manufacturing plants have been doing recently, determined to locate at a little greater distance from the city. After considerable investigation, 14 acres were purchased on the main line of the Pittsburgh & Lake Erie Railway, 12 miles from Pittsburgh. This property extends from the railroad to the Ohio River. At this point, the writer wishes to digress long enough to question the reader: As a student of economics would you consider such a purchase advisable?

Slightly less than half of the property is covered by the present plant. In preparation for this plant, the ground level had to be raised above high water mark. For this purpose approximately thirty thousand cubic yards of pulverized slag were used as fill. This was only sufficient to bring the ground level of the present building up to the desired elevation. The remainder of their property will be brought up to this level by dumping ashes from the boilers and similar refuse at advantageous points.

This plant was designed for the purpose of producing approximately thirty thousand to forty thousand tons of forgings per year. The output to be sold chiefly among the automotive, tractor, railroad and mining industries, while its shear knives will be sold among rolling mills and other plants which might have occasion to use them.

The idea pursued in designing this plant was to provide a layout which would permit of extension of any of the departments without interference with the general plan of installation, and the arrangement of machinery was made with the idea of reducing operating cost to a minimum and at the same time providing for more or less special items of forgings which this company produces.



Exterior view of new drop forge plant of the Pittsburgh Knife & Forge Co. at Coraopolis, Pa., showing water tower. The forge shop is located at the right and the boiler house in the foreground. In justice to the Pittsburgh Knife & Forge Co. it must be stated that this cut does not do their plant credit, as an elevation could not be found from which a good picture could be secured.

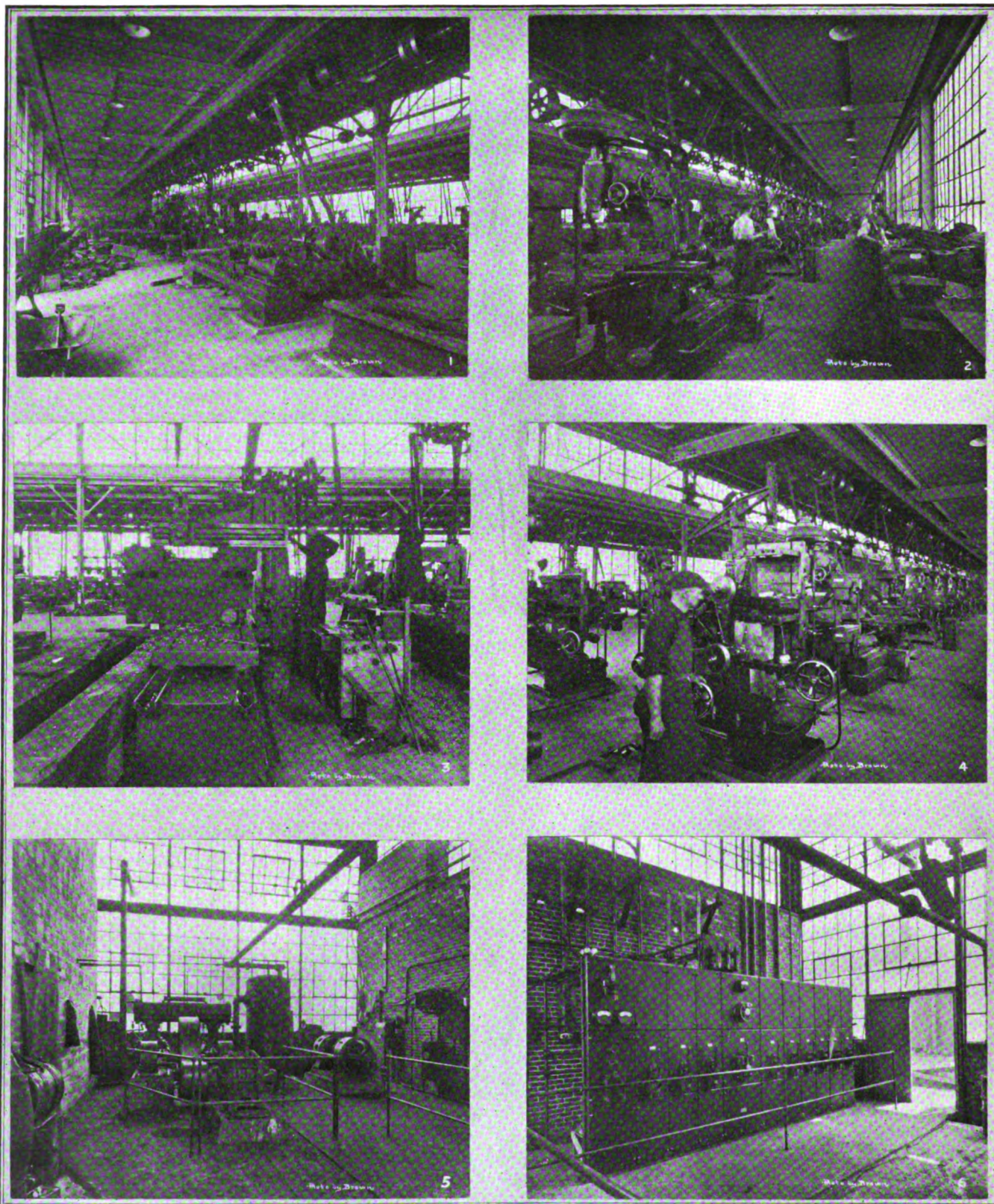


Fig. 1—View of repair department in the machine shop, Pittsburgh Knife & Forge Company, showing lathes and planers used in making repairs on all shop equipment.

Fig. 2—View from upper end of die sinking department showing Becker typeless die sinking machines in foreground.

Fig. 3—Showing open side planer making repairs on hammer base. This is a particularly difficult job.

Fig. 4—Close-up view of Keller automatic die sinker.

Fig. 5—Chicago Pneumatic Tool Company air compressor used for supplying all the compressed air used in the plant.

Fig. 6—General Electric Company switchboard. Particular attention is called to the great number of windows in this plant.

An inspection of the plant layout, Fig. 13, will give a very good idea of the plans pursued in effecting this arrangement. On one side is the forge shop proper with the steel storage at the upper end, through the center of which runs a spur track. Opposite the forge building is the machine shop, including die room, repair department, inspection department, offices, and the power plant. This building is served by two spurs, one running parallel to the boiler house for the purpose of dumping coal, and the other running along the inside of this building at such an elevation that the finished forging may be loaded directly into box cars by means of electric trucks from the inspection department. There is an alleyway, 45 feet wide, between the forge building and the building used for machine shop and other auxiliary purposes. This is primarily for the purpose of not interfering with the air circulation. This space may also be utilized as a storage for forgings.

The Forge Shop.

The forge building proper is 65 feet wide by 700 feet long, 30 feet to the crane rail and 63 feet to the top of the monitor. Construction work was done by the Memphis Construction Company and is essentially of brick and fabricated steel. Particular attention is called to the number of windows which permit easy ventilation and abundant light. Along both sides are sliding doors which can be raised to a height of 12 feet in the summertime, thus making conditions as comfortable as possible for the workmen. Of this building, 420 feet are utilized as the forge shop, and the other 280 feet as the steel storage yard. The entire building is served by a ten-ton crane, which will handle any of the equipment in this building with the exception of hammer bases. The crane is equipped with magnets and scales, and is also used for unloading steel, handling scrap and other work of this nature. A trench 30 inches wide and 24 inches deep extends along the wall all around the inside of the forge building. In this trench are placed the water lines, high pressure air lines, oil line and steam lines. The trench is connected with the main sewer every 40 feet to take care of water and condensation. One feature to which particular attention is called is the manner in which oil is kept warm in the winter time. The three-inch oil line and the four-inch steam line are bound together with pipe covering, thus assuring the fact that the oil will flow freely during cold weather.

It was at first planned to use gas for heating the furnaces, but the shortage of natural gas in the Pittsburgh vicinity made this impossible. Consequently oil is used in all the furnaces. An 18,000-gallon oil storage tank is located under ground in the alley way between the two buildings, as will be seen in Fig. 13. In the stock yard are located two Williams & White and a Buffalo Armor Plate shear. The metal is unloaded from cars or taken from stock to the shears, where it is cut to length, and then taken to the hammer or press on which it is to be forged.

Looking down the forge shop from the upper end, the board hammers are located on the right (Fig. 8) with their accompaniment of heating furnaces and presses. From the trimming press the parts are loaded into steel containers, which are picked up by the electric trucks and taken to the inspection department, where they are inspected and ground preparatory to shipping. As will be noticed, four pickling tanks are located in the corner of this building, where the stock

will be pickled preparatory to forging. Seven Chambersburg board hammers, ranging in size from one thousand to two thousand five hundred pounds, are driven by two 50-hp motors with the line shaft carried on one side of the building. Extra heavy pipe is used as a bracing between the hammers and line shaft. Six panel boards in this building take care of all motors. They are 8 feet above the floor along the wall with underground conduit running through each machine. Each machine is controlled by a push button type switch and no operator is permitted to handle any of the switches on the panel board. Opposite the board hammers are located the steam hammers (Fig. 7), a list of which will be found under the layout (Fig. 13). A 12-inch steam line supplies the hammers at 125 pounds pressure, and a 15-inch line takes care of the exhaust steam which returns to a hot water heater in the boiler room and through which the steam is exhausted into the air. During the winter months the exhaust steam is used for heating the offices, inspection department, machine shop, etc. The heating furnaces are all of their own construction, the air blast for same being supplied by eight Spencer blowers, each of which produces 6,750 cubic feet of air per minute at one-pound pressure.

These blowers are placed over the shop office on one side and the lavatory on the opposite side of the forge shop; four on each side. This arrangement provides spare capacity in case any blower should be down for repairs. It further places the blowers in a central position with regard to the entire length of the forge shop, thus giving a more uniform air pressure. The blast pipe is carried overhead along the side of the building. The lower end of the forge shop is not as yet in operation. Therefore, all that can be said about it at this time is that it has been designed and arranged for production work on several special types of automobile and railroad forgings.

Die Sinking Department.

The building utilized for machine shop and other auxiliary purposes is 70 feet wide by 420 feet long and is 15 feet high under roof girders. It has a 4-foot brick wall with steel sash to roof and a monitor type roof with ventilating sash. The die sinking department, Figs. 2 and 4, occupies the southwest corner of this building and includes four Keller automatic die sinking machines, a close-up of one being shown in Fig. 4. A 40-inch Lodge & Shipley lathe, a Pedrick & Ayer milling machine, a 34-inch boring mill, a No. 3 Becker die sinker, five No. 3 Pratt & Whitney die sinking machines, several lathes, a Brown & Sharpe grinder and a Keller universal grinder are found in this department. To facilitate handling of material to the various machines in this department, a 1½-ton hand crane is placed overhead. Approximately 200 feet at the lower end of this side of the building is occupied by the die sinking department.

Repair Department.

Directly opposite the die sinking department is the repair department (Figs. 1 and 3), which is equipped with a number of large lathes and planers. Attention is invited to Fig. 3, in which a 36-inch Cleveland open-side planer is being used to square up the hammer base. A 1½-ton crane, similar to the one in the die sinking department, is located in this department.

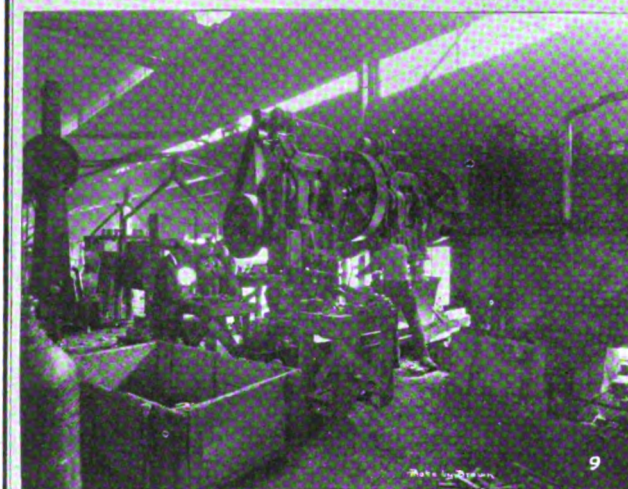


Fig. 7—View of steam drop hammers from the upper end of the forge shop.

Fig. 8—The other side of the forge shop showing board hammers.

Fig. 9—Rail anchors are made on two Toledo presses, which are fed by a continuous furnace of their own design.

Fig. 10—Tate-Jones die block furnace with Leeds & Northrup potentiometer, recorder and controller in the foreground.

Fig. 11—Wash room for convenience of the workmen. It is well equipped with lockers, showers and wash stands.

Fig. 12—Several Automatic Transportation Company electric trucks used in carrying material from the forge shop to the inspection department and from the inspection department to the loading platform. This figure also shows the sliding door which can be raised to a height of 12 feet.

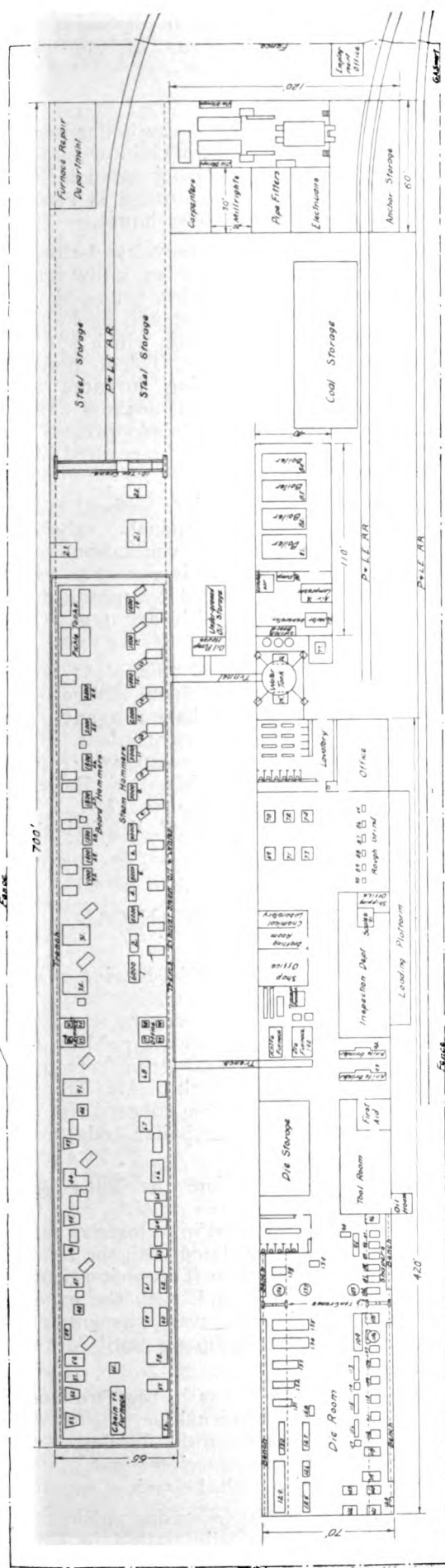


Fig. 13—Layout of Pittsburgh Knife & Forge Company's new plant at Coraopolis, Pennsylvania.

- | | | | | | | | |
|-----|------------------------------------|-----|---|------|------------------------------------|--------|---|
| 1. | 6000 lb. Erie Steam Hammer | 47. | 3-inch Acme Upsetter | 91. | 3000-lb. Toledo Automatic Seales | 137. | 13-inch Baker Drill Press |
| 2. | No. 7 Williams & White Press | 48. | No. 2½ Chambersburg Press | 92. | Springfield Grinder, 16-foot Table | 138. | 32-inch Cincinnati Shaper |
| 3. | 5000 lb. Chambersburg Steam Hammer | 49. | 4 Spindle Rockford Drill Press | 93. | Springfield Grinder, 16-foot Table | 139. | 24-inch Peerless Hack Saw |
| 4. | No. 6 Williams & White Press | 50. | 2-inch Ajax Upsetter | 94. | No. 2 Robertson Hack Saw | 140. | 24-inch Peerless Hack Saw |
| 5. | 5000 lb. Chambersburg Steam Hammer | 51. | Upsetter | 95. | 21-inch McCoy Brand Lathe | | CARPENTERS' EQUIPMENT |
| 6. | No. 6 Williams & White Press | 52. | 80-lb. Bradley Hammer | 96. | No. 2 Diamond Die-Surface Grinder | 1. | Wood Turning Lathe |
| 7. | 3000 lb. Erie Steam Hammer | 53. | 60-lb. Bradley Hammer | 97. | 16-inch Baird Shaper | 1. | Power Rip Saw |
| 8. | No. 57 Toledo Press | 54. | Chain Furnace | 98. | 24-inch Eberhardt Shaper | 1. | Shaper |
| 9. | 3000 lb. Chambersburg Steam Hammer | 55. | Eye Bender | 99. | 24-inch Eberhardt Shaper | 1. | Bank Saw |
| 10. | No. 57 Toledo Press | 56. | 6-Spindle Foote-Burte Drill Press | 100. | 32-inch Eberhardt Shaper | | MILLWRIGHTS' EQUIPMENT |
| 11. | 3000 lb. Chambersburg Steam Hammer | 57. | No. 27 Williams & White Bulldozer | 101. | 32-inch Eberhardt Shaper | 1. | Hack Saw |
| 12. | No. 54 Williams & White Press | 58. | Tate Jones Continuous Furnace | 102. | 32-inch Cincinnati Shaper | 1. | Lathe |
| 13. | 3000 lb. Chambersburg Steam Hammer | 59. | No. 12 Williams & White Shear | 103. | 32-inch Cincinnati Shaper | 1. | Bolt Threader |
| 14. | No. 54 Williams & White Press | 60. | Queen City Shear | 104. | 40-inch Lodge & Shipley Lathe | 1. | 12-inch Grinder |
| 15. | 1500 lb. Massillon Steam Hammer | 61. | No. 12 Williams & White Shear | 105. | 34-inch Rogers Boring Mill | | PIPE FITTERS' EQUIPMENT |
| 16. | No. 11 Williams & White Press | 62. | No. 13 Williams & White Shear | 106. | No. 3 Becker Die Sinker | No. 9 | Jarecki Pipe Threader |
| 17. | 1500 lb. Massillon Steam Hammer | 63. | No. 23 Williams & White Bulldozer | 107. | No. 3 Pratt & Whitney Die Sinker | 3-inch | Bulldog Ratchet Die |
| 18. | No. 56 Toledo Press | 64. | No. 4 Williams & White Bulldozer | 108. | No. 3 Pratt & Whitney Die Sinker | 1. | Pipe Vise |
| 19. | 1500 lb. Massillon Steam Hammer | 65. | No. 5 Williams & White Bulldozer | 109. | No. 3 Pratt & Whitney Die Sinker | 1. | Hollow Anvil |
| 20. | No. 56 Toledo Press | 66. | No. 59 Toledo Press | 110. | No. 3 Pratt & Whitney Die Sinker | 1. | Horn Anvil |
| 21. | No. 10 Williams & White Shear | 67. | 1500 lb. Chambersburg Blacksmith Hammer | 111. | No. 3 Bradford Lathe | 2-inch | Pexto Roll |
| 22. | No. 10 Buffalo Shear | | | 112. | 18-inch Bradford Lathe | 2-inch | Pexto Edger |
| 23. | No. 11 Williams & White Shear | | | 113. | No. 3 Brown & Sharpe Grinder | 1. | Pexto Wiring Machine |
| 24. | 2500 lb. Chambersburg Board Hammer | | | 114. | 18-inch Bradford Lathe | | ELECTRICIANS' EQUIPMENT |
| 25. | 1800 lb. Chambersburg Board Hammer | | | 115. | Small Tool Grinder | 1. | 18-inch Lathe |
| 26. | 1500 lb. Chambersburg Board Hammer | | | 116. | No. 5 Becker Die Sinker | 1. | 10-inch Hack Saw |
| 27. | 1500 lb. Chambersburg Board Hammer | | | 117. | No. 6 Becker Die Sinker | 1. | 10-inch Drill Press |
| 28. | 1500 lb. Chambersburg Board Hammer | | | 118. | No. 4 Keller Automatic Die Sinker | | OIL HOUSE EQUIPMENT |
| 29. | 1400 lb. Chambersburg Board Hammer | | | 119. | No. 4 Keller Automatic Die Sinker | 2 | 4" x 4" Triple Worthington Pumps |
| 30. | 1000 lb. Chambersburg Board Hammer | | | 120. | No. 4 Keller Automatic Die Sinker | 2 | 7½-hp Motors |
| 31. | 6-inch Ajax Upsetter | | | 121. | Cook Pump 200 gal. per min. | | ADDITIONAL EQUIPMENT |
| 32. | 5-inch Acme Upsetter | | | 122. | Cook Pump 200 gal. per min. | 1 | Pease Blueprinting Machine |
| 33. | | | | 123. | Sub-station 22000 Volt Transformer | 50 | Motors, 5 hp to 100 hp, or a total of 1500 hp in use |
| 34. | | | | 124. | 75-hp Reliance Motor-Generator Set | 1 | Portable Concrete Mixer |
| 35. | | | | 125. | Chicago Pneumatic Air Compressor | 2 | Electric Trucks |
| 36. | | | | 126. | National Feed-Water Pump | 2 | 1½-ton Cranes in Die Room |
| 37. | | | | 127. | 210-hp Uniflow Boiler | 1 | 10-ton Crane in Forge Shop |
| 38. | | | | 128. | 210-hp Uniflow Boiler | 1 | 36-inch Magnet |
| 39. | | | | 129. | 210-hp Uniflow Boiler | 12 | Steel Trucks |
| 40. | | | | 130. | 216-hp Uniflow Boiler | 1 | Spencer Blower, 4,700 cu. ft. Air per min. in Heat-Treat. Dept. |
| 41. | | | | 131. | Rough Grinding Stand | | |
| 42. | | | | 132. | Rough Grinding Stand | | |
| 43. | | | | 133. | Rough Grinding Stand | | |
| 44. | | | | 134. | Rough Grinding Stand | | |
| 45. | | | | 135. | Rough Grinding Stand | | |
| 46. | | | | 136. | Rough Grinding Stand | | |

The Inspection Department.

The next 40 feet of this building is utilized as a store room and hospital on one side, and on the other side for die storage. Separated from the rest of the building by a tile wall is the heat treating department, which occupies the next 60 feet of the same building. It is utilized for grinding and heat treating dies and shear knives. Fig. 10 gives an excellent view of the Tate-Jones die furnace, which is automatically controlled by a Leeds and Northrup potentiometer. Not all of the equipment has as yet been installed in this department. Above the heat treating department is located the superintendent's office and draughting room on one side, and the inspection, grinding and shipping departments on the opposite side. This arrangement places the last mentioned departments directly opposite the main runway between the forge shop and the machine shop, thus making it but a short haul for the electric trucks from the hammers to the inspection tables. It is planned to install a mono-rail system for the purpose of carrying parts from the forge department to the inspection department, where a rotary inspection table is located, on which the forgings will be dumped. The inspectors will stand inside this circular table, and, as the forgings pass, they will examine them, tossing same into the scrap or into the bin as accepted parts.

At the present time all parts are carried from the forge department to the inspection department on lift trucks manufactured by the Automatic Transportation Company, Buffalo, N. Y., several of which are shown in Fig. 12. Special containers of their own manufacture are used in this work. After inspection they are again loaded on trucks and automatically weighed on Toledo no-spring scales, and then loaded directly into box cars, the floor level of which is opposite the loading platform. The grinding department is located just beyond the inspection department, and opposite it will be located three Toledo presses, a consolidated press, and two Chambersburg presses. In the end of this building are located the general offices and the wash room, which is shown in Fig. 11. The wash room is well equipped with metal lockers, showers, wash stands, etc. An instantaneous water heater is another feature of this room.

Pump House.

The water supply is secured from two wells equipped with Cook pumps which have a capacity of 200 gallons per minute. These pumps serve a fifty-gallon overhead storage tank which is noted in the figure on the first page of this article. One pump will take care of all the water needed for the shop, while the other is utilized as a spare. These pumps start and stop automatically at certain levels in the tank. They also keep a pressure of 30 pounds per square inch on the water lines.

Sub-Station.

In the sub-station, several views of which are noted in Figs. 5 and 6, is found a 22,000-volt transformer, the main switch board, Fig. 6 (General Electric Company), 75-hp Reliance motor generator set, a Chicago Pneumatic Tool Company air compressor, Fig. 5, and a National feed water pump. The current for the operation of the plant is purchased outside. The plant is operated on 440 volts ac with the exception of the crane, which is operated on 230 volts dc, and the lighting system, which is served at 110 volts ac. Attention has been called to the

lighting of this plant. Figs. 5 and 6 emphasize this feature more particularly than any of the other illustratoins.

The Boiler House.

Next to the sub-station is found the boiler house, which is equipped with four 216-hp Uniflow boilers. These are all hand fired. By referring again to Fig. 13 it will be noted that the coal storage is located conveniently with regard to the boiler house.

Space is also provided for the removal and storage of ashes. When completed the electrician, millwrights, carpenters and pipe fitters will be located as shown in Fig. 13. Next to this department will be located the equipment for making rail anchors, which will include two continuous furnaces, two Toledo presses with oil quenching tanks, reheating furnaces and other necessary equipment. The rail anchors are at this time being made on several Toledo presses as shown in Fig. 9. All floor space will be covered with concrete.

This article would not be complete without referring again to the lighting. The unusual number of windows and the arrangement for ventilation have been mentioned. At night the shop is almost as light as during the day. This is effected by means of a large number of lights located with due regard to shadows in the roof of each building.

The layout and construction of this plant were under the direct charge of Mr. Edwin Hodge, Jr., president; Mr. J. G. Gardner, purchasing agent, and Mr. William Kahn, general superintendent. The other officers and executives of the company are Mr. W. H. Schoen, Jr., vice president; Mr. J. S. Bassett, secretary; Mr. A. R. Bassett, treasurer; Mr. J. A. Egbert, production manager, and Mr. F. W. Strickler, auditor.

NEW EDITOR FOR "MECHANICAL ENGINEERING"

The American Society of Mechanical Engineers announces the appointment as Managing Editor of C. E. Davies to succeed the late L. G. French, who was both editor and manager of the society's publication. The June issue of "Mechanical Engineering" contains a symposium of eulogies on the work of Mr. French, including resolutions of appreciation adopted by the council of the society and by the boiler code committee.

Mr. Davies was graduated from the Rensselaer Polytechnic Institute with a degree of M.E. and for several years afterwards specialized in industrial management work. He became associated with the Smith Premier Works of the Remington Typewriter Company, Syracuse, N. Y., in 1914, and, with the exception of fifteen months during the war, was engaged in production work with that company until March, 1920.

During the war Mr. Davies was in the Ordnance Department at the Frankford Arsenal, serving as assistant production superintendent on the Artillery Ammunition Division and later as superintendent of the fuse shop. He left the service with the rank of captain.

The society has secured for its increasing publication and extensive meetings one especially trained in large diversified business undertakings.

Electric Motor Drive for Traveling Cranes

A General Discussion of Electric Motor Drives for Cranes—The Question of Manual vs. Magnetic Control for Cranes Is Thoroughly Discussed.

By GORDON FOX,
Electrical Engineer, Freyn-Brassert & Co.

PART II.

THE torque and power required to accelerate the motor armature and mechanism may be found from the same formulas as applied for hoisting. This will be found ordinarily to be a relatively small item.

Starting torque is the governing factor in a trolley motor. It should therefore govern the motor selection. The draw bar or tractive effort required in starting, neglecting armature inertia, is

$$DB = \frac{D_t \times D_a \times W}{2000}$$

In order to reduce this to torque at the motor the gear ratio must be determined. The current input in starting may be considered as averaging 150 per cent full load current. This produces, with a series motor, a little more than 150 per cent full load torque. The per cent motor torque for free running condition may then be found by the approximate formula

$$T_r = \frac{D_t}{D_t \times D_a} \times 150$$

Where T_r = per cent full load motor torque at free running or foot-pounds at motor arm

A motor may be tentatively selected by judgment. From the characteristic curves of this motor the speed corresponding to the per cent load torque T_r may be found. Knowing the motor rpm, above, and the free running velocity V of the trolley, the motor revolutions per foot trolley travel N may be found by the formula

$$N = \frac{\text{rpm}}{V}$$

The torque T_m at the motor corresponding to draw bar pull DB may now be found by the formula

$$T_m = \frac{DB}{2\pi N}$$

This value of motor torque exists during the uniform acceleration period. It may be taken as 150 per cent full load torque of the motor desired. A motor may then be selected whose 150 per cent torque is approximately equal to T_m .

If this motor differs widely from the tentative selection, a check is desirable. However, a line of similar motors does not vary greatly in speed characteristics, so that the method should give results as accurate as the basic assumptions.

If a trolley is to be used for regular cycles of operation the above selection should be based on the 60 minute rating. Moreover, a check on heating should be made. The method will follow closely that outlined for the hoist motion. Since acceleration load is most severe, heating is greatest when short trips are made. The heating depends both on rate and frequency of acceleration.

In selecting a free running speed, acceleration rate, motor size and gear ratio for a man trolley, the necessity

and value of speed should be first considered. A little additional speed may represent considerable additional cost. A high free running speed involves a gear ratio less favorable to rapid acceleration, requiring higher motor torque and a larger motor to obtain the desired acceleration rate. It is well to plot velocity time and distance time curves showing advantage of one gear ratio over another. The decision should be based on the average travel or the travel where speed is most important. It will be found that if the average travel distance is short, high free running speeds are of little or no advantage.

The hoisting and racking speeds of a conveying man trolley should be so coordinated that neither causes delay nor is unnecessarily fast. It is well to plot the locus of the moving bucket to see that this represents the shortest feasible distance.

Bridge drives for cranes differ considerably in layout, depending upon the character of the crane. In the ordinary overhead traveling crane one motor is mounted on the side of one of the girders. This motor drives a line shaft or "squaring" shaft which, in turn drives the wheels. There are usually two or more gear reductions involved. In cranes of long spans, two motors may be used, located near the ends of the span, both on one girder and driving the same line shaft, operating in series or parallel. Heavier cranes are frequently equipped with a line shaft on each girder, each line shaft driven by a motor. On small cranes having two wheels on each end truck, half the wheels are driven. On larger cranes having four or more wheels for each end truck, one half or one quarter of the wheels may be driven, depending upon design. The smaller gantry cranes are provided with a single bridge motor, bevel gearing being introduced into the line shaft drive. Large gantry cranes, such as coal and ore bridges are generally constructed to permit skewing and are equipped with separate drives for each leg. These drives commonly operate through wheel traction but cables and winding drums are sometimes used.

The travel speed of cranes and bridges varies over rather wide limits. Obviously, large structures such as coal and ore bridges cannot be moved rapidly. These equipments travel at speeds ranging from 50 to 120 feet per minute. The bridge speeds of overhead traveling cranes are higher than the trolley speeds as the travel distances are ordinarily greater. These speeds range from 175 feet per minute for large ladle cranes to 300 feet per minute or more for fast yard cranes. The usual crane bridge speed, under load, is about 225 to 250 feet per minute.

The load of a crane bridge drive is similar in nature to that of the trolley and has the same component elements. Bridge drive conditions are somewhat more uncertain and less favorable, however. Crane runways are frequently out of alignment, causing excessive flange

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friction. Squaring shaft bearings are liable to some misalignment and excess friction. Cranes are sometimes improperly used for pulling cars or cobbles. These factors introduce abnormal loads. It has been found by test and experience that the friction draw bar pull of a crane with all conditions favorable, will be 20 to 30 pounds per ton whereas a stiff crane and poor track will require about 50 to 60 pounds per ton friction draw bar. Good average practice may be taken as 40 pounds per ton. The torque and power required to overcome friction load may be found by the same formulae as set forth for the trolley calculations, substituting bridge values.

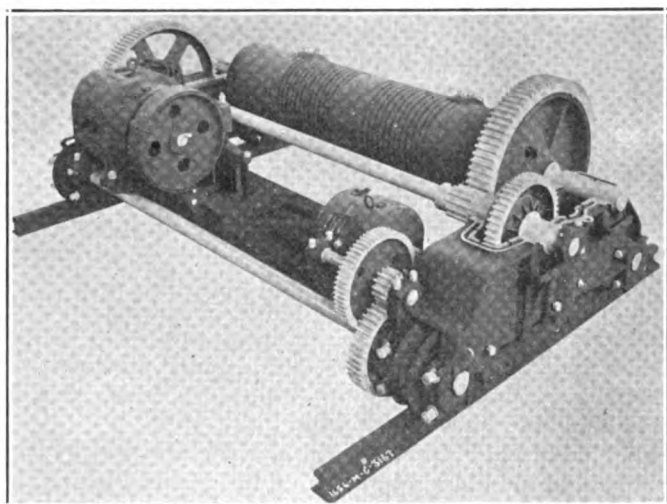


Fig. 2—Showing general arrangement of hoist and trolley drives.

The rate of acceleration of coal and ore bridges is about .5 feet per second per second. Large overhead cranes, gantry cranes or standby cranes are best arranged for acceleration at about 1 foot per second per second. A good average figure for mill and yard cranes is 1.5 to 2 feet per second per second. For very fast service, values up to 3 feet per second per second may be used. It should be noted that an acceleration of 2 feet per second per second is about the limit that can be reached without wheel slippage for a crane having one-fourth of its wheels driven and the weight equally distributed. A crane which is liberally motored and has but one-fourth the wheels driven may tend to slip the wheels excessively. This will run up mechanical maintenance costs. Over motoring is less serious where magnetic control is used to limit current input to safe accelerating values. Uniform acceleration at 2 feet per second per second means acceleration to 300 feet per minute velocity in 2.5 seconds while traveling 6.25 feet.

The torque and power required for acceleration of the bridge motion may be determined from formulae applied to the trolley, adapted to bridge values. The motor acceleration requirements may be determined from the formula already given.

In the case of outside cranes it is customary to figure the draw bar pull due to the wind friction on the basis of 10 pounds per square foot of area exposed in the travel direction. It is not ordinarily expected to operate in winds higher than this value.

The motor size selection and gear ratio determination for the bridge drive may follow closely the method suggested for trolley drive determination. Due to the un-

certain elements of bridge friction, it is desirable to have some leeway in the bridge motors.

The use of alternating current motors for crane drives often seems desirable as power is available in that form only. Although the induction motor is not inherently adapted to crane service, it may be made to perform very creditably. For hoisting duty a wound rotor motor is employed. A mechanical load brake or special solenoid brake is used to govern in lowering. Unlike the direct current series motor, the full running speed is closely fixed regardless of load. The crane speed should be determined on the basis of prevailing service which is a partial load condition. If an induction motor be geared for this speed it will cause the crane to have a higher full load speed than the same crane equipped with a series motor and geared for the same light load speed. The induction motor must therefore have about 50 per cent higher hp rating but, if it is also rated for a higher speed, the difference in weights may be minimized.

For driving the trolley motion of small and moderate sized cranes a high resistance squirrel cage motor is popular. This motor is connected directly across the line. But three trolley wires are required. For larger trolleys and for speeds above 125 feet per minute trolley travel, wound rotor motors are used.

A brief comparison of alternating current motor drive and direct current motor drive may be of interest.

A crane equipped with alternating current motors is frequently higher in first cost than a crane equipped for direct current drive. On the hoist motion a mechanical load brake is necessary or a special solenoid brake as above described. On the trolley and bridge drives, starting torque is of great importance, to obtain rapid acceleration. In order to obtain the desired torques larger and heavier motors may be required, if alternating current is used. Increased weight and size of motors necessitates heavier crane members. The cost of a crane equipped with alternating current motors will often run 15 to 20 per cent higher than for a similar crane with

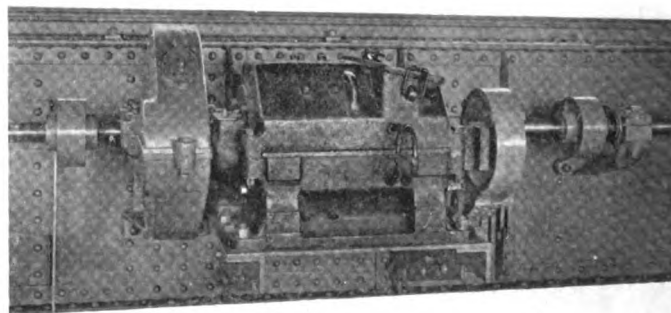


Fig. 3—Showing bridge-drive motor attached to side of girder and driving squaring shaft.

direct current drives. Where four or more cranes are involved, this extra cost will about offset the cost of equipment for conversion of the power to direct current.

In the matter of reliability there is little advantage. The alternating current motor has no commutator. It has, however, a small air gap. The direct current motor is more easily dismantled for repairs. Slip ring motors are used for all but very light cranes. They require six collectors against four for direct current motors. The control equipment for alternating current motors is frequently more complex. Magnetic control for alternating current involves larger contactors and is fundamentally not the equal of direct current magnetic control.

Crane duty is essentially high torque duty. Alternating current motors are not the equal of direct current series motors in this respect. They require proportionately higher starting currents which are taken at low power factors. The losses are higher than for direct current drive losses, including conversion loss. Where conversion equipment is supplied a high power factor may be maintained.

A great advantage of the direct current crane is in the flexibility of speed and nicety of control. When handling light work a direct current crane will operate at about twice its full load speed. This makes for maximum service from a given equipment. If an alternating current crane is geared for high speeds it will be shy in starting torques unless very large motors are supplied. An alternating current crane has one full speed for all loads.

Direct current control of cranes permits excellent control over a wide range of speeds. In hoisting, a creeping speed with positive torque can be readily obtained. The lowering speed is independent of the hoisting speed and, by means of dynamic braking, lowering can be perfectly controlled and the load decelerated with a minimum of brake wear.

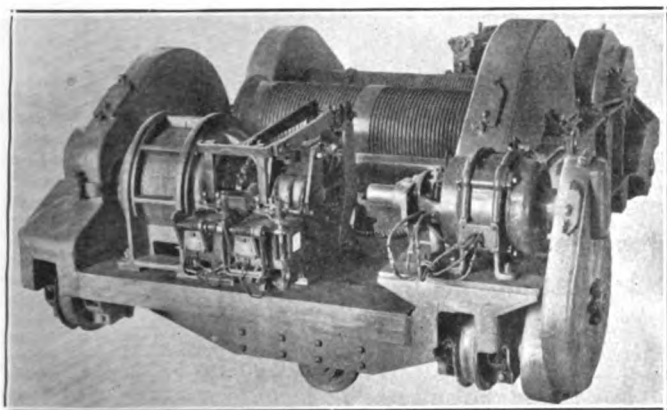


Fig. 4—Trolley equipped with induction motors. The hoist motor is supplied with a two-element brake. One element acts as a holding brake, the other provides variable braking torque in lowering.

Due to the superior torque characteristics of the direct current series motor the acceleration of direct current cranes is usually more rapid than that of alternating current cranes, where compromise is necessary. Thus the direct current crane tends to be a faster all around equipment.

Direct current cranes may be easily equipped for magnet handling whereas a motor generator is necessary to supply a magnet used on an alternating current crane.

The foregoing remarks have dealt primarily with crane motors and their selection. A brief outline of crane control methods and principles follows. As the great majority of cranes are direct current equipped, this type will be mainly considered. The hoist, trolley and bridge control will be considered separately.

Most cranes are equipped with a single hoist motor. Sometimes a straight reversing controller is used with an armature shunt provided in the lowering direction. This has advantage in the matter of simplicity but is open to the disadvantage that lowering speeds with heavy loads tend to be much higher than with light loads. Dynamic braking control is the prevailing type. This

permits adjustment of lowering speeds independent of hoisting speeds and also permits adjustment of relative light hook and full load lowering speeds.

Hoist motors are commonly equipped with series wound brakes. When very high lowering speeds are employed, as on coal and ore bridges sufficient current does not flow through the brake circuit to hold it open. It is therefore often necessary, in such cases, to provide shunt wound brakes.

Sometimes two motors are provided for a hoist drive. They are sometimes connected in series but more often in parallel. In case of parallel connection one motor will handle the load at reduced speed. It is well to have such motors oversize, with this end in view. Difficulties may arise, with motors in parallel, due to failure of one motor while running. Also, in lowering, the motors may not divide the load equally unless special provision is made in the control. Some ladle cranes are provided with a ratcheting device which requires the motors to divide the load. Such hoists cannot be lowered with a single motor except by releasing manually the brake or brakes not in circuit.

Alternating current hoist motors provided with load brakes are equipped with straight reversing control. The mechanical brake retards the descending load. A separate solenoid brake is used to decelerate the armature and load and to hold the load suspended. When the adjustable solenoid brake is used, the control is specially adapted.

The trolley motion of the ordinary traveling crane is provided with straight reversing control. No brakes are used. Sufficient resistance should be provided so that plugging on the first point of the controller will not give excessive current nor slip the trolley wheels.

Man trolleys of coal and ore bridges are often equipped with reversing control which may or may not be adapted for plugging. It is preferable that plugging be made safe through use of plugging resistance as this practice must be at least occasionally expected. Solenoid or air operated brakes are used for stopping and holding the trolley. Due to the wear of mechanical brakes when employed for stopping heavy, regularly operated man trolleys, dynamic braking is often preferred. For this purpose the control should be so arranged that the dynamic braking is obtained by short circuiting the reversed armature through the series field and resistance. Braking is then obtained independent of any outside source of power, resulting in a most safe arrangement. A drift point is commonly provided and is of advantage. Solenoid holding brakes are used. When a motor driving a trolley or bridge is to be regularly employed for deceleration by plugging or dynamic braking, this must be considered in determining the heating of the motor.

The bridge motion of a crane is usually provided with a straight reversing controller with two or more speed points. When magnetic control is provided, current limit relays are commonly used to govern acceleration. Time element acceleration offers advantages. It is frequently necessary to adjust current limit relays for high current values to insure starting of the crane at bad points in the track. Time element acceleration insures sufficient torque available for bad conditions yet protects the motor so far as possible for average conditions. Most traveling cranes having fixed cages are provided with foot brakes for decelerating and stopping. When the cage is on the trolley, stops may be made by plugging, the control being properly adapted, or solenoid brakes may be used. In the latter case the shunt brake is of advantage in that a drift point may then be included

in the control. Such brakes are subject to considerable wear and are difficult to maintain in adjustment.

In the case of large bridges sudden jerks are to be avoided. Wind conditions must also be considered. If a reversing control is used the first point should be arranged with high resistance to restrict the plugging torque to a safe value. A creeping speed is often provided by shunting the armature or the entire motor. This is used when traveling with the wind. Dynamic braking is sometimes employed, similar to that described for trolley control. Solenoid holding brakes are used. It is suggested that these solenoids be shunt wound because series brakes have been known to drag on light loads and wear the shoes or bands losing their holding power and thus introducing a dangerous condition. Rail clamps are often employed, their control being interlocked with that for the bridge motors. Where separate drives are provided for the trucks at the two ends of the bridge a limit switch is provided to act upon the bridge controller to limit the skewing to a safe amount.

The question of manual vs. magnetic control for crane service is much discussed. Magnetic control is particularly desirable for the larger motors. Sometimes the practice is followed to use manual control on the smaller motors, up to 30 to 50 hp perhaps, and to use

magnetic control for the larger motors. This is not strictly logical but may be most practical. Standby cranes may be equipped with manual control in order to restrict first cost. However, if the motors on a standby crane are based on low rates of acceleration to restrict motor size, it is difficult to insure, with manual control, that the operator will not attempt to accelerate rapidly and overload the motors. The general tendency, with manual control, is to accelerate too rapidly, resulting in shock to crane, slipping wheels and overloading the motors. Manual control is satisfactory in the hands of good operators where service is not severe. Magnetic control offers the following advantages:

- Protects motors, in a measure, against abuse.
- Provides small, compact master controllers which may be accessibly grouped.
- Renders operation easier and less exacting.
- Relieves operator, enables him to operate more motions. It is necessary on cranes having many complex motions.
- Give automatically, maximum safe acceleration, thus aiding to fast operation.
- Is safer and more easily maintained, more flexible for special design features.

Electric Furnaces for Making Steel

General Features and Advantages of the Electro-Hearth Arc Furnaces — Feature of These Furnaces Are That They Have a Single Arc and One Movable Electrode.

By ALFRED STANSFIELD, D.Sc., A.R.S.M., F.R.S.C.,
Birks Professor of Metallurgy at McGill University.

PART VI

AN electrode-hearth arc furnace, in its simplest form, has a single arc and one movable electrode; the furnace hearth itself being conducting and serving as the other electrode. The single electrode form of the Girod furnace see Fig. 26, may be taken as an example. In the electrode-hearth, as in the series-arc furnace, the contents of the furnace serve as one pole of each electric arc, and the electric current passes through these contents. In both kinds of furnace there must be one movable electrode for each arc. The electrode-hearth furnace can be made simpler than the series-arc, as it may contain only one arc and one electrode. It is also simpler to operate because there is only one arc in each electric circuit and thus each arc is independent of the others. On the other hand the conducting hearth is a source of some difficulty, both in construction and maintenance, and the earlier furnaces of this class were operated at lower voltages than the series-arc furnaces.

The Girod furnace, Fig. 26, has a number of water-cooled steel electrodes embedded in the hearth, for completing the electric circuit. A more recent furnace, that of Snyder, has the same construction. The Keller furnace has a conducting hearth made by ramming burnt magnesite amongst a number of iron rods. These furnaces have, in common, the difficulty of repairing the hearth without covering up the hearth-electrode and thus interrupting the electrical connection. In the Chaplet furnace, contact with the hearth is made by an iron electrode which enters the metal in a lateral channel. In

this way the difficulty of repairing the hearth is avoided and, also the danger, possessed by the other furnaces, of the steel finding its way through the hearth and causing an explosion when it meets the cooling water.

The furnaces already mentioned are the only ones in which an absolute electrical contact is made to the contents of the furnace, and in which the furnace cannot be started without such contact. We now come to a number of furnaces, with somewhat complicated connections, in which the hearth is actually conducting and carries a part at least of the electric current, but in which the hearth contact is not essential for operation, and the hearth only becomes a conductor when strongly heated.

The earliest of these, the electro-metals, Fig. 27, devised by Gronwall, resembled a Heroult furnace with two movable electrodes, but had, in addition, a fixed carbon electrode in the bottom of the furnace which was covered by the magnesite lining of the hearth. This furnace was supplied with two-phase current, each phase of which was connected to one of the movable electrodes and to the fixed bottom-electrode. When the furnace was cold the hearth was not a conductor and the furnace operated with the two arcs in series, utilizing the effective voltage of the combined phases between the movable electrodes. As soon, however, as the furnace was strongly heated, the hearth became conducting and each phase of the electric current circulated through one movable electrode, one arc and the bottom contact. Later furnaces depend on the same general principle, although

metal contacts, not carbon, are now used in the hearth.

The electrode-hearth furnace offers certain advantages as regards steadiness of electrical load and supply of heat to the hearth and lower part of the furnace contents, and in the later varieties, in which no metal rods pierce the hearth, there is no serious drawback to offset these advantages.

The earlier furnaces of all kinds employed single-phase current. With increasing sizes this became unsatisfactory, in view of the usual conditions of electrical

used, and the number can apparently be increased indefinitely, using single-phase current and coupling all the electrodes together. It is further possible to use three electrodes and three-phase current by connecting the hearth to one leg of a star-connected transformer system, as in the Greaves-Etchell furnace. The remaining furnaces of this class have either two or three electrodes and an equal number of arcs.

Most arc furnaces of the "direct-heating" type are operated with short arcs, because, with short arcs, the heat is produced closer to the material to be heated and the roof of the furnace is screened better from the heat of the arc by the electrodes themselves than if longer arcs were employed. Comparing furnaces of equal

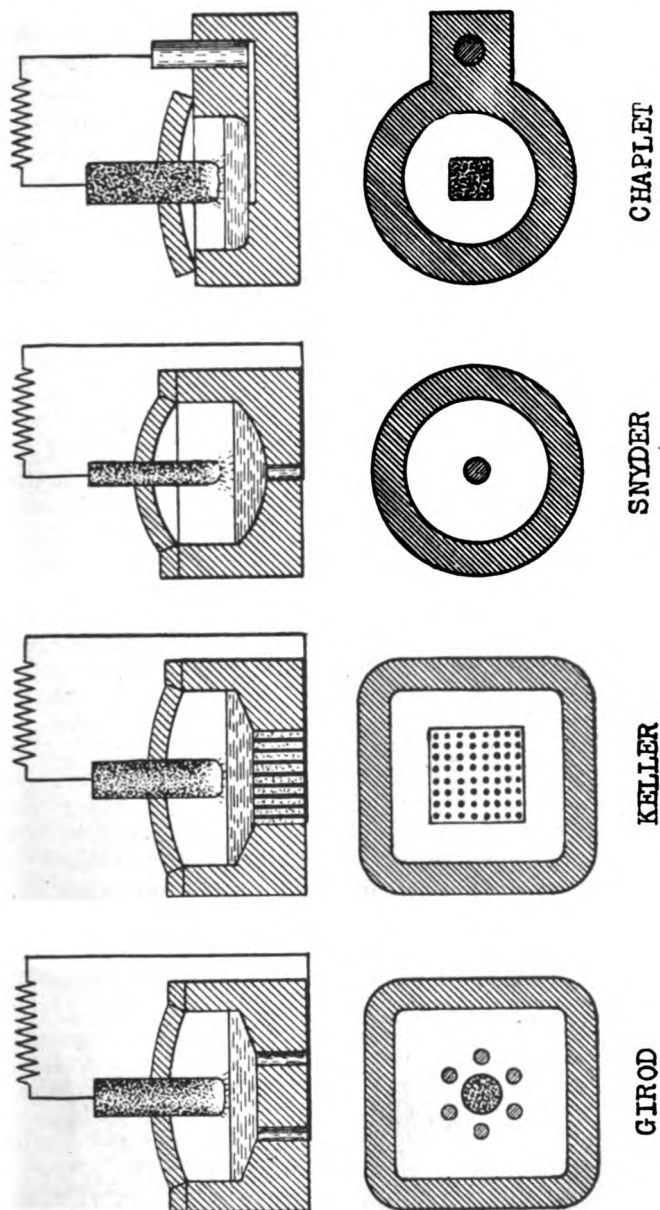


Fig. 26—Diagram of electrode-hearth furnace.

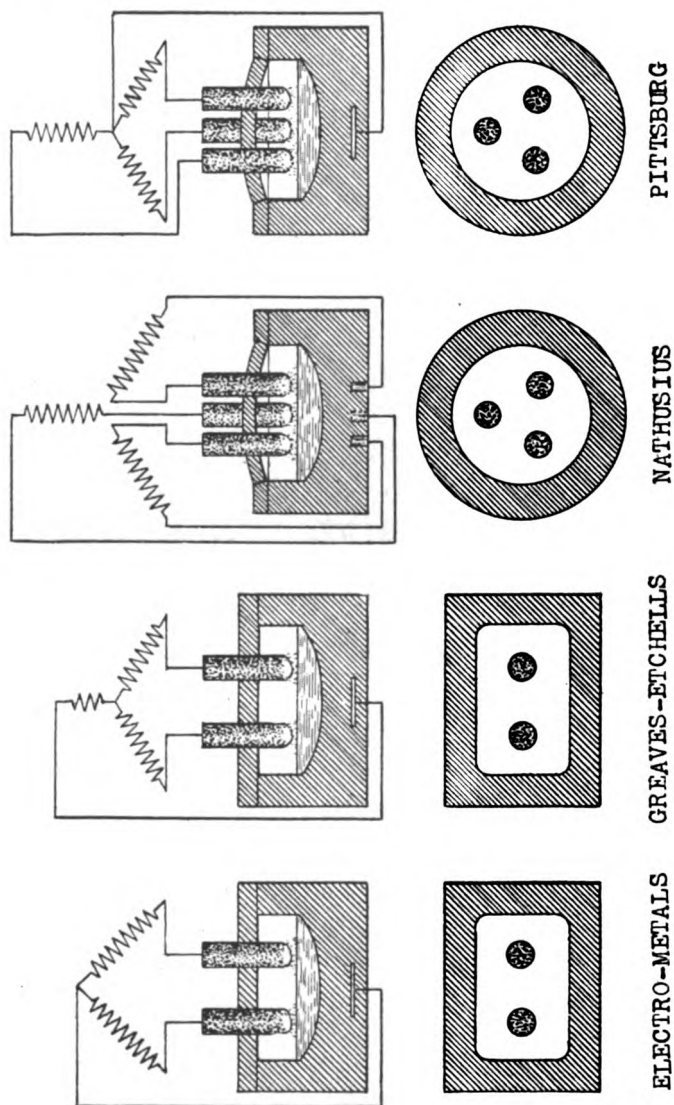


Fig. 27—Diagram of electrode-hearth furnace.

supply, and it became desirable to build polyphase furnaces. The Heroult furnace was readily adapted to three-phase current by the addition of a third electrode. The single-electrode furnaces of Girod, Keller and Snyder cannot be adapted to the use of polyphase currents without losing their characteristic simplicity of construction, but the recent forms of electrode-hearth furnace, including the Snyder furnace, are all designed for two-phase or three-phase current. In a later form of the Girod furnace four arcs and four electrodes are

lengths of arcs, and therefore of approximately equal voltage of arc, it will be obvious that electrode-hearth furnaces must be operated at lower voltages than series-arc furnaces, as the latter have two arcs in series while the former have but one arc in each electric circuit. Electrode-hearth furnaces will, on this account, have a lower efficiency as they suffer the thermal and electrical losses of the hearth-electrode and of the cables leading to the bottom contact, while neither of these losses occur in series-arc furnaces.

Safety Campaign Waged by Steel Company

Algoma Steel Company at Sault Ste Marie, Ontario, Have Received Gratifying Results From Publicity Campaign on Safety.

THE application of publicity to the solution of the industrial accident problem is the key note of the safety campaign which has been going on in the plant of the Algoma Steel Corporation at Sault Ste. Marie, Ontario, since first of October last. As a net result the campaign has been pronounced a success by the general manager and is being kept up. Thus far there has been a diminution of over 50 per cent in the number of accidents, over 70 per cent in the monthly amount of time lost (thus showing a decrease of this percentage in the severity of accidents). Exact figures are not as yet available as to the decrease in the amount of compensation payable, but it is estimated to be of about the same percentage as the decrease in severity.

The theory underlying the whole campaign is that the personal element is responsible for over 95 per cent of all accidents. Hence, the problem is attacked by

spectors, and a written report made thereon, careful note being taken as to the cause of the accident, whether the carelessness of the victim or someone else, faultiness of the machinery, of the methods of operation, etc.

In every case where pure carelessness was shown to be the cause of the accident, disciplinary methods were adopted.

Throughout the plant and in the columns of the house organ, stress was laid upon the fact that safety was a live issue; that the best superintendent was the safe superintendent; that the best foreman the safe foreman, and that it was a disgrace to any superintendent or foreman to have a preventable accident occur among his men. Moreover, in the columns of "The Algoman," published monthly, a list of every accident was made, giving the name of the victim, the name of the superintendent, the name of the department and the name of the foreman. This had the effect of jacking up everybody, by making it a matter of intimate personal interest to him to avoid accidents.

In order to keep the accident situation constantly before the eyes of everybody in the plant from day to day, huge indicator boards, with sliding thermometric indicators, were erected at every gate in such a position that every man, passing in or out, necessarily sees the exact standing from day to day, each day of the month. These indicator boards are so arranged as to give a comparative view of the situation each day on the same day of the previous month. The theory underlying the erection of these boards is to have everybody in the plant so inclined to think "Safety" at all times that everybody will be more careful; and everybody being more careful, there would, of necessity, be a reduction in the number of accidents. The experience of the Algoma Steel Corporation would seem to have shown this theory to be correct.

In addition to the inspection of mills and the investigation of accidents, the system in the medical office maintained at the plant was also re-organized in such a way that the safety department was placed in possession of a daily report, in writing, showing the number of dressings made on the previous day, the condition of each patient, nature of injury, progress from day to day, with special report in each case on the first, third and sixth day following the accident. These medical reports are filed away together with the accident investigation reports in every case, no matter how slight the accident, no matter whether the victim be off work for one day or one hundred days. Every case is fully accounted for, so that if, at any future time, demand is made for information regarding any accident case in the plant, whether such demand be made by the Compensation Board or any other interested party, the corporation is in full possession of all the facts in the case. The advantage of this is that in the case of claims arising after a lapse of weeks or months, following an alleged accident, full details of this accident (if there was an accident at all) are available, with the name of witnesses, testimony of witnesses, the exact place where accident occurred,



Fig. 1—"Safety First" board.

educating the human machine. In this education reliance is placed absolutely upon the psychological power of the printed word in all its forms—in other words the pulling power of publicity. Use is made of this power to inculcate lessons on safety, the whole to the general effect that thoughtlessness is the cause of carelessness, which, either directly or indirectly, is the cause of all accidents; that neither men nor machines are designed to make or cause accidents; that if men or machines do cause accidents it is because they go out of the beaten track of what they are designed or intended to do; that every accident denotes something wrong with men, methods or materials—but especially with men; because if materials are wrong or methods are wrong it is because men made them so or allowed them to remain so. These safety truths were embodied in pithy form in thousands of posters distributed or posted all over the plant, huge bulletin boards were erected and a house organ, "The Algoman," was founded, with safety as the sole plank of propaganda.

The safety department was thoroughly re-organized and a system of mill inspection, as well as accident investigation, instituted. Every unsafe place in the mill, insofar as possible, was guarded; every accident, no matter how small, was investigated by safety in-

the exact time, how it occurred and whether the victim was attended by a physician, and, if so, what the physician's finding was, etc.

Comparative Monthly Statement of Accidents.
From January 1, 1920, to May 1, 1921.
Safety Campaign opened October, 1920.

Month	Average No. Men	No. of Accidents	Days Lost
January, 1920	3,265	63	1,678
February	3,279	45	993
March	3,475	48	945
April	3,388	56	1,109
May	3,166	50	1,123
June	3,090	45	1,040
July	3,012	53	1,202
August	2,993	63	996
September	3,147	61	867
October	3,106	42	605
November	2,884	47	376
December	2,146	29	319
January, 1921	925	3	50
February	2,324	15	153
March	1,700	19	295
April	918	7	*62

*Estimated disability.

	No. Accidents Per Day	No. Accidents Per No. of Men Employed
January, 1920	2.032	.0193
February	1.483	.0131
March	1.548	.0138
April	1.866	.0165
May	1.613	.0158
June	1.500	.0146
July	1.710	.0176
August	2.032	.0210
September	2.033	.0194
October	1.358	.0135
November	1.566	.0163
December	0.935	.0135
January, 1921	0.097	.0032
February	0.536	.0065
March	0.613	.0112
April	0.233	.0076

FRANK J. MCGUE,
Director of Safety.

Campaign's Lessons.

Looking at these figures in their true significance, as regards the men working in the plant, what is the lesson that they convey?

The great lesson is the considerable economic saving effected for the men themselves—in their general well being, their persons, their pockets and their efficiency.

Conservatively estimating the average daily wage earned by the men in the plant at \$6, one finds that steel plant employees, during the pre-campaign period, suffered a loss of \$59,718 in wages—that is to say—9,953 days lost time at \$6 a day, or an average of 1,105 days lost per month, making an average total of \$6,630 lost in wages every month.

During the campaign period one finds this \$6,630 monthly loss reduced to \$1,590—and the figures are still going down.

But, apart from this pecuniary loss to the man, is the general economic loss, both to man and to the corporation, resulting from the disorganization incident to many absences, replacement of absent men, training of new men to fill the gaps, general loss of efficiency, in fact, general chaos.

And this quite apart and distinct from the terrible moral loss resulting from accidents and the suffering endured both by the individual man who is injured, and by his family; the impairment of the individual's working ability and his efficiency; the maiming of men; in fact, no matter how one looks at the situation, one must be convinced of the fact that the safety campaign has been productive of well nigh incalculable good for everybody, for the man, for his family, for the general well-being and efficiency of the plant and for the corporation.

Further Proof of Decrease.

Another interesting feature of the accident situation is the classification as to nature of injuries received and the percentage of lost-time attributable to these various injuries.

Taking the campaign months—October, November, December, 1920, and January, February, March and April, 1921, as a basis and comparing them with the same seven months of 1919 and 1920—that is to say, October, November, December, 1919, and January, February, March and April, 1920, one finds that in the last mentioned period there were 316 accidents with 6,396 days of lost time as a direct result of said accidents. For the same period of time covered by the campaign, that is to say, from October 1, 1920, to May 1, 1921, there were 155 accidents entailing a loss of time of 1,789 days.

In these figures, distributing the accidents as to their nature, one again finds evidence of the decrease in severity. For instance, there is a falling off in the number of fractures, the number of infections, and, especially, in the number of miscellaneous injuries, notably foreign bodies in eyes. This is directly attributable to the educational work which we have been carrying on.

The percentage of accidents under the various classifications and the percentage of lost-time caused by said accidents for the two periods were as follows:

October 1, 1919, to May 1, 1920: Total of accidents, 316. Total time lost, 6,396 days.

	Percentage of Accidents	Percentage of Time Lost
Contusions	38.5	33.1
Lacerations	26.6	25.7
Burns	13.2	10.4
Sprains	8.2	5.9
Infections	3.4	4.9
Fractures	6.7	17.8
Miscellaneous (such as foreign bodies in eyes, asphyxiation, ruptures, etc.)	3.4	2.2

October 1, 1920, to May 1, 1921: Total of accidents, 155. Total time lost, 1,789 days.

	Percentage of Accidents	Percentage of Time Lost
Contusions	36.7	36.4
Lacerations	25.8	22.2
Burns	19.1	13.7
Sprains	10.2	8.6
Infections	2.3	2.7
Fractures	4.4	15.7
Miscellaneous (such as foreign bodies in eyes, asphyxiation, ruptures, etc.)	1.5	1.0

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Steel Company Completes Improvements

The Electric Alloy Steel Company Expend Nearly a Million Dollars in Improvements and Additions at Their Charleroi, Pa., Plant — Will Manufacture Alloy and High Grade Tool Steels.

By DONALD N. WATKINS.

IT is an unquestioned fact that insofar as quantity production of steel is concerned, America is pre-eminent. However, varying from the general condition in America and feeling that equally as good steel could be made here as anywhere else on earth, if the question of quantity was forgotten and quality was placed foremost, a representative group of men, who, in their individual capacities, are actively associated with the production of over one-half of the total steel made in America, organized the Electric Alloy Steel Company, Youngstown, Ohio, for the purpose of carrying out their conviction.

The following men were the organizers and are the active directors: A. E. Adams, president of the First National & Dollar Banks of Youngstown; T. J. Bray, president of the Republic Iron & Steel Company; L. J. Campbell, formerly vice president of the Youngstown Sheet & Tube Co.; Maurice Joseph, president of the Joseph Joseph & Bros. Co.; Severn P. Ker, president of the Sharon Steel Hoop Company; L. A. Manchester, general counsel for the Youngstown Sheet & Tube Company; S. Livingstone Mather, secretary of the Cleveland Cliffs Iron Company; Chas. S. Thomas, formerly president of the De Forrest Sheet & Tin Plate Company; W. A. Thomas, formerly president of the Brier Hill Steel Company, and Jonathan Warner,

president of the Trumbull Steel Company. These men met in Youngstown, January, 1920, and selected the following officers: L. J. Campbell, president; A. E. Adams, vice president; W. D. Myres, secretary-treasurer, and Gustaf Peterson was appointed general manager of sales. Later a plan was formulated to take over the plant of the Universal Steel Company at Charleroi, Pa., and rebuild it to suit the manufacture of high-grade steel. This plant was actively taken over June, 1920, and in August of the same year the rebuilding plans were put under way. Barton R. Shover was secured as consulting engineer and under his direction and that of G. W. Knight, chief engineer of the company, such equipment was installed as would assure from the beginning the very highest quality of steel.

To begin with, the new plant is ideally situated for the manufacture of steel. It is located on a 12-acre tract bordering on the Monongahela River about 40 miles above Pittsburgh. The property also has connection with both the Pennsylvania and P. & L. E. Railroads. The land is underlaid with a 6½-foot vein of river coal. Gas wells are also being drilled upon the property in the expectation that the company may be able to secure a flow of this fuel from their own land.

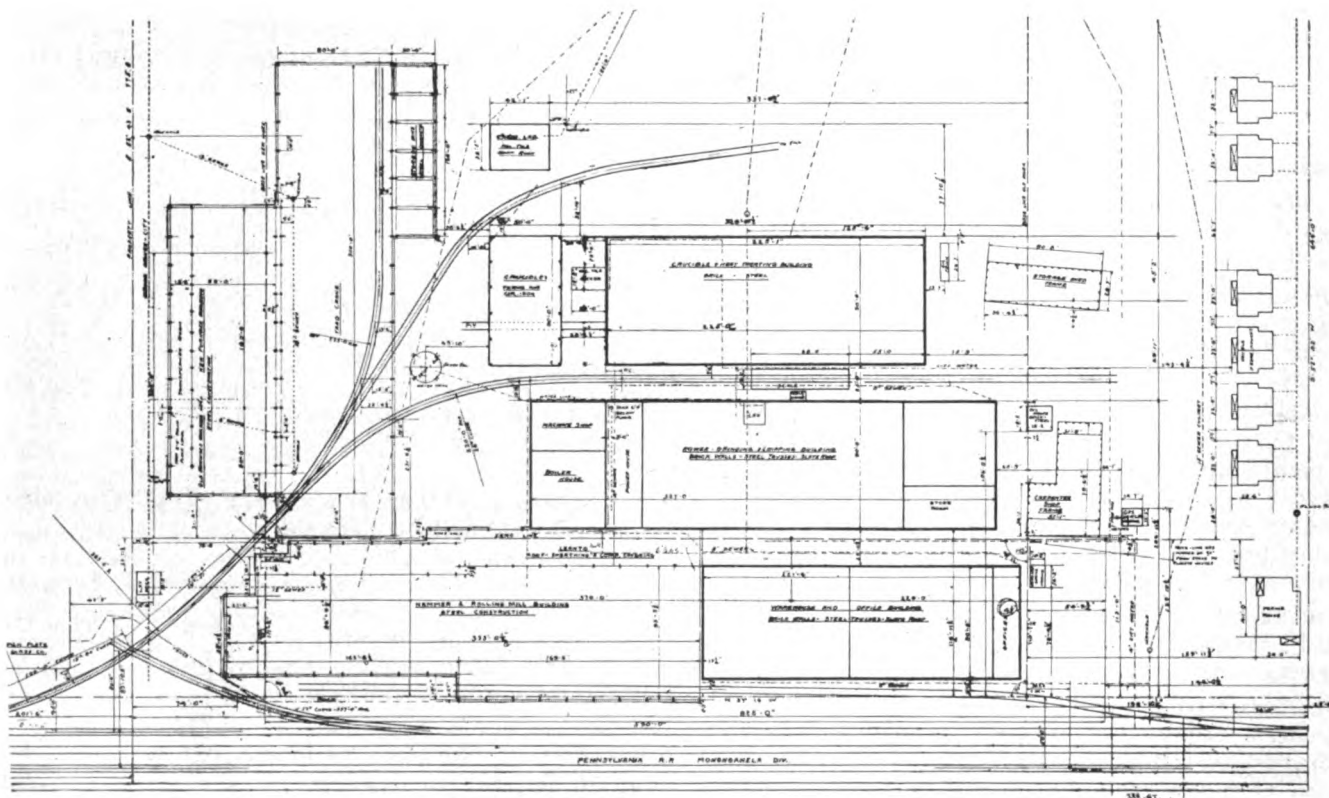


Fig. 1—General plant layout.

Stock Yards.

The raw materials which consist principally of clean, low phosphorous and sulphur scrap, Swedish muck bar, and imported and domestic ferro alloys are received by rail in the 330-foot x 80-foot building which covers the stock yard. This building is equipped with a 10-ton overhead crane made by the Alliance Machine Company. Electric Controller and Manufacturing magnets are used in picking up the raw materials. In addition to this, there are storage bins which cover 120 feet x 30 feet.

Steel Producing Facilities.

Steel is manufactured by two processes, the electric furnace process and the crucible process. The electric furnace building, which is 200 feet x 75 feet, contains 1 Heroult 6-ton electric furnace. A second 6-ton electric furnace of the same type, with all the latest Westinghouse equipment, is being installed. Housing facilities have been provided and foundations have been set for a total of four 6-ton electric furnaces, all of which will eventually be installed in this building.

The electric furnace building is equipped with two 15-ton overhead electric cranes. One was made by the Alliance Machinery Company and the other by the Whiting Corporation. The steel is poured from the electric furnace into Gathmann moulds of special design through a pouring buggy especially designed for box pouring. Ingots are made of sufficient size to allow proper working and grain refinement in finishing department. Included in the equipment of the electric furnace building are annealing and cooling pits. These pits are used in order that the steel may be cooled slowly to remove any internal stresses. The ingots are hauled from these pits to the rolling mills or stock yards on ingot buggies by a Westinghouse Baldwin Electric Locomotive.

The rolling mill department contains a 10-inch and a 16-inch mill. These mills are the latest design, and were made by the A. Garrison Foundry Company. The 16-inch bar mill is equipped for rolling rounds in tool and alloy steel up to 4-inch diameter. It is also equipped to roll squares and flats up to the same area. The 10-inch mill is equipped for rolling tool and alloy steels of various sizes and shapes. All rolls used in these mills are designed and turned at the plant. The mills are driven by a Garrison Foundry & Machine Co. steam engine. Feeding these two mills are two coal-fired heating furnaces of special design.

The cooling bed and shearing capacity will easily take care of the output of the mill.

Crucible Department.

The crucible department consists of one building 90 feet x 60 feet and an additional equal space in another building. 225 feet x 90 feet. Each of these buildings contains a 24-pot crucible furnace. Utmost care is taken, particularly in the material used in the production of high-speed steels, which are made in these buildings. All steel is poured from the pots into a 3-ton Whiting ladle and then into the ingot moulds. From here the steel is delivered to the hammer shop and mills.

Hammer Shop.

The hammer shop equipment includes the following series of hammers: one 650-pound Chambersburg tilt hammer, and 1,000, 2,000, 3,500 and 8,000-pound Chambersburg steam hammers. There are four forced-

draft coal-fired heating furnaces of special design with under-hearth flues used. There is also one double furnace of similar design and one small gas-fired furnace for tilt hammer use, exclusively. These furnaces were all designed and built by the plant organization. The hammer shop is to be equipped with a 5-ton overhead traveling crane.

Sound, clean surfaces on the finished product are assured by extensive grinding and chipping capacity. Twelve new grinders of the latest improved swing frame type, individually motor driven, have just been installed. These grinders were made by the Springfield Manufacturing Company. Ample chipping capacity has been provided. Thor chipping hammers are generally used throughout the plant.

Annealing Department.

The annealing department is equipped to take care of bars up to 25 feet in length. This department's equipment consists of a series of furnaces, the principal one of which is a large car type annealing furnace. There are also a number of furnaces, some gas and some electric heated, which were designed and built by the plant organization. Uniformity of temperature in annealing is assured by control with multiple point recording pyrometers of the latest Leeds & Northrup and Wilson & Maculen types. Hardening equipment takes care of the high-speed tool bits and of alloy and tool steels in bars up to 6 feet in length. This equipment consists of a lead vat, vertical quenching tanks and oil and salt drawing vats.

Inspection Department.

All processes in the mill are under regular chemical and metallurgical supervision. All scrap and raw materials which enter into the composition of the steel are without exception carefully sampled and analyzed on their receipt to insure uniformity of product. The large chemical laboratory which consists of a room devoted solely to preliminary and final analyses and a general laboratory for the crucible steels, raw materials and special analyses are part of the equipment of the plant. In addition there is a sampling room containing drill presses, a crusher, milling machines, air hammers and other sampling equipment. There are also special rooms for carbon determinations, sulphur determinations, electrolytic equipment and a balance room. A telautograph is to be provided to report analyses to the electric furnace department.

During the course of manufacture the purity of the steel is constantly watched by inspection under the microscope. Soundness of the steel and uniformity of heat treatment are further checked by the use of a binocular microscope.

The equipment for mechanical tests consists first of a 100,000-pound tensile testing machine, a Swedish Brinell machine, scleroscope and portable Brinell meter. New equipment just built at the plant includes an impact testing machine similar to the Charpy type, and a repeated stress testing machine is to be installed. For investigation of new steels and their heat treatments a critical point apparatus is being installed, consisting of a Rosenhain furnace used in conjunction with a new type of portable precision potentiometer. The latter instrument is of new design by the Leeds & Northrup Co. It is also to be used in checking pyrometers against Bureau of Standards calibrated couples.

Power.

The steam power for the plant is generated in a very modernly equipped boiler house. This boiler house contains two 333-hp Wickes vertical boilers equipped with Murphy automatic stokers and draft regulators. Other equipment included are Wilson-Snyder pumps, a Copes feed water regulator and Berry ari compressors. Exhaust steam is used for preheating feed water. A new coal conveyor is now under consideration.

The water used in the plant is pumped from the Monongahela River by a Triplex pump to a large water tower. This tower serves the plant, mills and furnaces in general.

Some electric equipment of the very latest Westinghouse type has recently been installed. Electric power for operating the plant is purchased from the West Penn Power Company. Their lines enter into an outdoor switching station at 22,000 volts, 3 phase, 60 cycles. At this point the lines are protected by electrolytic lightning arresters. From the main switch, current is carried to a 22,000-volt buss in the transformer room, to which three banks of transformers are connected through proper switching. The total load is about 4,000 kva. Two banks of transformers supply the two electric furnaces. The voltage on the furnace is 110, and each furnace consumes about 8,000 amperes per phase. The power transformers reduce the 22,000 volts to 2,200, which is carried from the transformer room to the sub-station. Here it is distributed to the various parts of the plant. In the sub-station is located the motor generator set which furnished direct current for the cranes, etc. A 1,300-cubic-foot-per-minute Chicago pneumatic air compressor is installed. This furnishes compressed air for the entire plant. There are also two small air compressors which are used in emergencies. In the sub-station one bank of transformers reduces the 2,200 volts to 220 volts for the operation of small motors. All high voltage lines and equipment throughout the plant are protected by screens, etc., to insure the safety of employees. The transformers were furnished by the Pittsburgh Transformer Company and the Westinghouse Electric & Manufacturing Co. The control apparatus for the cranes was made by the Cutler Hammer Manufacturing Company. Other electrical equipment was furnished by the General Electric, Cutler Hammer and Westinghouse Elec. & Mfg. Companies.

For weighing outgoing and incoming materials a new Fairbanks 300,000-pound capacity railroad scale has been installed. There are numerous other Fairbanks scales throughout the plant for weighing the ingots, scrap and other materials which are transported on narrow gauge tracks.

The office building contains accommodations for the entire office personnel, engineering department and purchasing department.

A number of very well-known operating officials have been placed in charge of the plant. The general superintendent is Geo. W. Morrison, formerly rolling mill superintendent, Carbon Steel Company, Pittsburgh; assistant general superintendent, in charge of steel making, L. B. Knox, formerly assistant works manager with the Sizer Forge Company, Buffalo; metallurgist, Marcus A. Grossman, formerly with the United States Bureau of Standards, Washington, D. C.; chief engineer, G. W. Knight, formerly with the

Westinghouse Electric Company and Midvale Steel Company.

REFRACTORIES FOR ELECTRIC FURNACES

R. M. Howe recently published an article in "Chemical and Metallurgical Engineering," describing the refractories available for use in electric furnace work, with some notes on their origin, details of the more important properties, the factors affecting their suitability for various duties, the best methods of utilizing them and precautions to be taken to obtain a satisfactory life. Various refractories not yet in commercial supply are also considered and their probable spheres of usefulness indicated.

The nine raw materials which enter into consideration are, fireclay, silica (ganister), magnesite, dolomite, chromite, bauxite, zirconite, carborundum and alundum. Typical compositions are quoted, together with the melting points. Various refractories, however, break down at temperatures below their melting point when subject to pressure and the relative figures are quoted for a number of samples. The specific gravity and electrical resistivity are given and the influence of temperature on the latter property indicated, all the materials showing a decidedly decreased resistivity with rising temperature. Specific heats and thermal conductivities are given where figures are available. The resistance of the refractories to temperature changes are classified, fireclay being much less susceptible than silica, magnesite and chromite.

Heat insulation of the refractories is to be avoided, and it is considered that water cooling of the outer surfaces would be a decided advantage in many instances. The satisfactory service given by silica bricks in furnace roofs is thought to be due to their high thermal conductivity and the fact that they remain rigid under pressure at high temperatures. Zirconia bricks are thought likely to solve many problems in furnace work when the commercial disadvantages in connection with their manufacture are overcome. For this it is essential that the raw material should be pure and it must be bonded into a mechanically strong brick which should undergo little shrinkage after being installed. Bauxite bricks are somewhat similar to zirconia. Carborundum and alundum bricks offer the same advantages as silica, but in addition are not likely to disintegrate so readily under fluctuating temperatures.

All bricks should be protected from rain during storage, laid with a cement composed of material similar to the bricks or one which will not corrode them and with as thin a joint as possible. The furnace should be constructed so that heat will readily be radiated from the hottest portions and the ratio of heating to cooling surfaces should be as low as possible. Refractories should be heated from one side only and insulation should be avoided even to the extent of preventing the accumulation of dust on the roof. When the furnace is being heated up this should be done very gradually, especially where magnesite or silica bricks are involved and when the furnace is being cooled, cold blasts should be avoided as these greatly accelerate disintegration of the refractories.

Common Electric Generator Troubles

How to Overcome Difficulties Arising In Generator Sets in the Shortest Possible Time — Delays Due to Such Trouble a Serious Factor In Steel Mill Production.

By F. A. SWEET.

WHEN a generator fails to produce current the cause can usually be traced to the inability of a self-excited unit to build up its field. To start such a unit properly a certain amount of field residual magnetism is required, which must be increased to full strength by the current generated in the machine itself. This trouble is not likely to occur in a separately excited unit, and if it does it is usually due to the failure of the exciter.

The cause of this condition is weak or destroyed residual magnetism, due to vibration or jar, proximity of another current, a strong current through the armature when there is little or no field current, which tends to neutralize or reverse the field owing to the reverse ampere turns, and accidentally reversed current through shunt or series field coils, which may not be enough to reverse the magnetism completely. Reversal of magnetism will not cause failure to generate. The symptom of this ailment is weak or no attraction when the pole pieces are touched with a piece of iron.

To relieve the condition, send a magnetizing current from another machine through the field coils, then start the generator again. If this fails, change the direction of the exciting current, since it may have enough polarity to prevent them building up in the case. Shifting the brushes backward will make the armature magnetism assist that of the field. Change the polarity of the machine so that influence of adjacent machines will have opposite effect.

Another cause to be reckoned with is reversed connections, or reversed rotation. An indication of this condition is the fact that while running the pole pieces will not attract a piece of iron. The application of external excitation will not, in this case, make the machine generate, because whatever field is built up is destroyed by the armature current.

The remedy is to reverse either the field or armature connections, to move the brushes through 180 degrees for two-pole, 90 degrees for four-pole, 60 degrees for six-pole, etc., or to reverse the direction of rotation. After any of the above alterations the field will have to be excited from an outside source.

Another cause is short-circuiting of either the internal or external circuit, which manifests itself in weak magnetism: If the short is in the external circuit it will prevent a shunt dynamo from building its field; but with a series machine, the building up of the field will be hastened. If the short is in the machine it will likely prevent the building up of either type. A slight short such as a defective socket or copper dust on the commutator may prevent a shunt machine from building up, as will also an overload.

Field coils opposed to each other are still another cause of failure to generate. The evidence of this condition is the appearance, when tested with a compass, of similar poles adjacent to each other. This state of affairs can be corrected by reversing the connections on the reversed poles.

An open circuit, which may be caused by a broken wire or faulty connection in machine, brushes not in contact, safety fuse being blown or circuit breaker being out, or an open switch will naturally cause failure to generate.

If the trouble is an external open circuit, the field of a shunt machine will be fully magnetized and the machine will be working perfectly; but if the trouble is inside the machine, the fields will be weak. A break in the field circuit of a separately excited installation will prevent generation, and is indicated by no field in the generator and full exciter field.

A break in a single-phase series-wound armature will result in non-generation; in a two-or-three-phase Y-armature will cause it to generate single-phase; while in a delta armature it continues to give three-phase, but at reduced capacity.

To remedy, make a careful inspection for open circuit in both field coils and armature. A break or excessive resistance in the shunt field or field regulator will also make the magnetism weak. This may be detected by cutting out the rheostat for an instant or by connecting the two terminals of the field coils to the brushes in first one and then the other direction.

A high resistance in the circuit of a series-wound machine will prevent building up. Short the machine momentarily to start the field.

Failure to generate may also be caused by the brushes being improperly placed. The tell-tale of this condition is a change in the magnetism and voltage when the brushes are shifted.

It frequently happens that the brushes are not set at the correct point or they may be set at exactly the wrong position, in which case the machine is incapable of delivering any current whatever. This trouble is probably due to the fact that no two machines have the same setting. Drawings should be obtained showing the proper position of the brushes before an attempt is made to set them.

Sparking at the commutator is a common trouble. One cause of this is excessive armature current, due to an overload on the machine, short circuit, ground, or excessively high voltage.

To remedy, reduce the load, eliminate the short circuit or ground, or reduce the voltage.

Brushes not set at the neutral point may cause excessive sparking. In this case the sparking will vary when the brushes are shifted. The brushes should be shifted until the trouble disappears. Care should be taken to see that the brushes are exactly opposite.

A commutator rough, eccentric, or with high bars will cause sparking, due to imperfect contact of the brushes. A rough commutator should be filed or stoned down, or even taken out and turned if extremely bad. Eccentricity may be in the armature or merely due to a loose bearing. If the former, it should be

turned down; if the latter, new bearings should be fitted.

In order that the commutator should wear smooth, the shaft should be allowed end-play of about one-eighth inch.

Other causes of poor conductivity at the brushes are dirty or oily brushes, a glass-hard brush which is incapable of wearing to a good seat, or a brush that has a specific resistance.

The remedy is to clear the fouled parts and replace poor brushes.

A short-circuited or reversed coil in the armature will cause sparking, which condition can be noticed by the excessive power required to run the generator without load. The short-circuited coil heats faster than the others and is likely to burn out unless promptly attended to. A piece of steel held between the pole pieces near the armature will vibrate as the defective coil passes.

Such a short is often caused by a piece of solder or other metal getting in between the commutator bars or their connections. The trouble is easily found and remedied. If, however, the short is in the coil itself the only reliable repair is to rewind the coil.

A broken armature circuit will cause violent flashing and the bar nearest the break will be badly burned. A poor contact somewhere in the circuit will have this same effect to a lesser degree.

Such a break or poor contact may be located by the drop of potential or continuity test. The break is usually in the connections between the coil and bar, where it can be readily repaired. If it is in the coil the only remedy is to rewind the troublesome part.

A ground in the armature will often cause sparking. When two or more grounds occur in the armature the result is a short circuit, and the case should be so treated. A single ground on electric railway-line or a three-wire system with the neutral wire grounded will have the same effect.

To find the ground, wrap a flexible conductor around the commutator. Apply a current through this will flow and the defective coil will be energized. It can then be located with a compass.

A weak magnetic field causes sparking. The tell-tale of this condition is weak pole pieces, and the point of least sparking is shifted considerably from the normal position. Full voltage or current is not forthcoming.

The causes of this condition are: 1. A broken circuit, which may be found by opening the field circuit after having insulated the field: if no spark occurs there is a break some place in the circuit. 2. Short circuit. 3. Grounding, which may be found by drop-in-potential method.

A broken circuit is easily repaired if accessible: if it is in the coil the coil will have to be rewound. If the circuit voltage is low, sparking will result. If it cannot be raised the field resistance should be reduced by unwinding a few layers of wire.

Flashing over is a spark jumping from one set of brush-holders to another or to the frame. This is caused by poor or insufficient insulation between the points mentioned, or by deposits of copper or carbon dust on the surface of the insulation. This latter is the usual cause, and the trouble can be eliminated by simply cleaning the parts with an oily cloth.

Ring fire is an exaggerated case of commutator sparking and may cause flashing from one set of brushes to the next. The remedies for commutator sparking will obviously do away with this trouble.

Any of the causes of sparking will cause heating of the commutator. In fact, heating frequently occurs from these causes before sparking is noticeable.

The next in importance is heat spreading from other parts of the machine. The machine should be started when cool and run for a few minutes, then a search made for warm parts before the heat has a chance to radiate to the rest of the machine.

These parts should be attended to as directed under their respective headings.

An overhead commutator will cause deterioration of the brushes and cover it with a black film, which offers more resistance and aggravates the trouble. The commutator should be cleaned and the different brushes fitted if necessary.

Brush connections may offer abnormally high resistance, which may be tested by the drop of potential method and improved.

Heating will occur when there is an arc or short circuit between bars or between bars and end ring. The arc will be noticeable when the machine is running. Burnt or otherwise defective insulation should be taken out and replaced.

Brushes of high specific resistance will produce heat. Better carbons or greater conductivity should be installed.

The friction of the brushes will also produce heat. This case can be differentiated from the preceding one by noting whether or not the temperature is excessive when the current is light. This may be due to heavy pressure or high speed. Reduce the spring tension. Decrease speed, but keep up the voltage by increasing the field. Lubricate slightly with oil or vaseline.

Excessive current will cause heating of the armature, as will also moisture in the coils. Moisture can be detected by steaming when hot. The armature should be taken out and baked for several hours at a temperature sufficiently high to drive out the moisture, but not hot enough to injure the insulation.

When the iron of the armature core is found to be warmer than the coils after a short run, and when considerable power is required to turn the armature when there is no current through it, and when the field is connected, indications are that there are eddy currents in the core. There is a question of poor lamination and a matter of primary construction.

Reversed coils in one part of an armature will cause local currents to circulate around a direct-current armature, causing a rise in temperature. This will mean excessive power to drive a generator without load. A compass will indicate the reversed coil when a current is sent through each coil separately. The remedy lies in simply reconnecting the terminals to agree with the rest.

Excessive current in the field circuit will bring about heating of the field magnets. A temperature of 1220 degrees F. above room, as determined by a resistance test, is considered high.

In the case of a shunt-wound or separately excited machine, decrease the field voltage or increase the resistance. In the case of series winding, shunt a portion of the current. This condition might be caused

by a short circuit, in which case the defective coil will be cooler than the others. As a check, measure the resistance of each coil; if there is any considerable variation, the low resistance coil is sure to be grounded or short-circuited.

In alternating or pulsating current work the field pieces will become heated, due to eddy currents, unless they are carefully laminated.

Moisture in these coils will cause short-circuiting and heating, as in the armature.

Heating of bearings is a condition to which any machine not properly constructed or attended to is subject. In cases where a stop for repairs would be fatal, temporary relief may be had by pouring cold water on the bearing or packing it in ice.

This state of affairs is usually due to lack of oil. The oil passages may be clogged, the reservoir dry, the oiling devices out of order. These defects should, of course, be remedied. Use good oil; it will be money well invested.

Grit in the bearings will cause heating. Remove the bearing and investigate for foreign particles. Scratches will be noticed. Remove the dirt, clean the bearing, use clean oil, and provide a dirt-proof casing if necessary.

A shaft that is rough, scored, or too large will also cause heating. It should be turned down in a lathe and refitted.

A sprung shaft presents difficulties in truing, and a new one is usually necessary.

A shaft turns hard and heats when the bearings are out of line. Conditions are relieved by loosening the holding bolts. Bolt the bearings in a position where the shaft turns freely, being sure that the armature is in the center of the field.

Thrust of a shoulder or the shaft against the bearings will generate heat, and is caused by the belt drive being out of line or by the armature not being centered axially with the field coils. The remedy will be found in lining up the belt or moving the collar to allow the shaft to center itself.

Too heavy tension on the belt or eccentricity of the armature will cause an extra load on one side of the bearing and heating of the bearing, which will wear elliptical in time and aggravate the trouble due to an eccentric armature. The belt tension should be decreased, using a larger pulley if necessary, and the armature should be centered. If the bearings have worn elliptical, new ones should be fitted.

The most frequent source of noise is the humming, speaking, or hissing of the brushes on the commutator. This trouble can readily be located by the ear. File or dress the brushes down with sandpaper and apply a little oil or vaseline. Changing the length of the brushes and the pressure often helps.

Vibration due to the revolving armature, field, pulley, or commutator being out of balance is, of course, objectionable. The parts should be taken out and balanced, separately, because a static balance of the whole combination is not likely to prove to be a dynamic one. A dynamic balance takes place only when equal moments are directly opposed to each other.

When the armature rubs against the pole pieces noise results. Bind down any abnormal projection on the armature; center the armature; chip off high spots on the field pieces.

Noise caused by the collar or pulley rubbing on the bearing is due to the same condition that causes bearings to heat, and should be so treated.

Rattling due to the looseness of parts can be eliminated by careful inspection of the machine before or after each run. Tighten up the loose parts. Replace a poorly fitting bearing.

The flapping of a belt joint on the pulley produces a disagreeable sound which should be stopped by making a better joint.

An intermittent squeaking sound which indicates a slipping belt, may be overcome by increasing the tension of the belt or by applying a belt dressing.

The humming of the armature core teeth as they pass the pole pieces ought not to occur if the machine is properly constructed. It can be relieved by sloping the edges of the pole pieces.

Humming due to alternating current is inherent to a large extent in alternators, but can be deadened by mounting the machines on felt or some such material.

Improper voltage is a common difficulty which may arise in any machine, and is due to the following causes: Field magnetism too strong or too weak; brushes not in proper position; generator overloaded; short-circuited or reversed armature coils.

All of these produce sparking and are dealt with under that head.

Speed too high or too low, or open short-circuited or reversed field coils may prevent a dynamo from generating current.

A direct or alternating-current generator, unless it is compound or composite, would tend to fall in voltage with increased load. This is usually overcome by raising the field current or by cutting out field resistance.—"Power House."

SHATTERED ZONES IN STEEL RAILS

J. E. Howard recently read a paper before the American Society for Testing Materials which deals with methods whereby interior shattered zones in steel rails may be located and examined; inferentially leading to the conclusion that shattered zones represent thermal effects, shrinkage cracks. In rails they are located along the middle of the head, and at the junction of the web and base; the period in which they form is conjecturally held to be at the time of cooling after the last pass of the rail mill. The shattered zones thus far examined have been confined to hard or medium hard steels.

In respect to the association of transverse fissures with shattered rails, transverse fissures have been found in rails both with and without shattered heads; and shattered heads have been found without transverse fissures. Thus it appears that a shattered state of the metal is not a necessary precursor to the formation of a transverse fissure.

The paper refers to a physical law explaining why the fissure has an internal origin, based upon the internal strains acquired by the rails in service. Attention is called to the distinction between causes which tend toward the rupture of all rails and the ultimate resistance of different steels whereby some rails resist certain wheel loads while others do not.

Rails are not regarded as permanent members in engineering structures by reason of the cold-rolling action of the wheels, which strains the zone of metal next to the top of the head beyond its elastic limit.

Proposed Revised Specifications for Steel Products

Abstract of Report Made by Committee at the Twenty-fourth Annual Meeting of the American Society for Testing Materials, Asbury Park, N. J., June 21-24, 1921.

Proposed Revised Specifications for Welded and Seamless Steel Pipe.*

THESE specifications cover "standard" and "extra strong" welded and seamless steel pipe, but not "double extra strong" pipe. Pipe ordered under these specifications are intended for bending, flanging and other special purposes.

I. MANUFACTURE.

2. (a) The steel for welded pipe shall be of soft weldable quality made by the Bessemer or open-hearth process. The steel for seamless pipe shall be made by the open-hearth process.

(b) Welded pipe 3 inches or under, in nominal diameter, may be butt-welded, unless otherwise specified. Welded pipe over 3 inches, in nominal diameter, shall be lap-welded.

II. CHEMICAL PROPERTIES AND TESTS.

3. Open-hearth steel shall conform to the follow-

This abstract of the report of the Committee on Steel, furnished to the American Society for Testing Materials, is published herewith because it will effect a majority of the steel producers. It is not possible for all of our readers to either attend the meeting of this society or obtain a copy of the report of this particular committee, and feeling that possibly some of our readers may have criticisms or suggestions to make on these specifications, which may be of real benefit, we have taken this means of presenting the same to them.

ing requirement as to chemical composition:

Phosphorus.....not over 0.05 per cent.

III. PHYSICAL PROPERTIES AND TESTS.

4. (a) The material shall conform to the following minimum requirements as to tensile properties:

	—Welded—		Seamless
	Bessemer	Open-Hearth	Open-Hearth
Tensile strength, lb., per sq. in..	50,000	45,000	48,000
Yield point, lb. per sq. in.....	30,000	25,000	26,500
Elongation in 8 in., per cent....	18	20	18

(b) The yield point shall be determined by the drop of the beam of the testing machine.

5. (a) Welded pipe shall be tested at the mill to the hydrostatic pressures specified in Table I.

(b) Seamless pipe shall be tested at the mill to

hydrostatic pressures not exceeding that required by the formula:

$$P = \frac{2 S t}{D}$$

in which P = pressure in pounds per square inch; S = allowable fiber stress = 16,000 pounds per square inch; t = thickness of wall in inches; and D = inside diameter in inches.

6. (a) For lap-welded pipe over 2 inches in diameter, a section of pipe 6 inches long shall be flattened between parallel plates until the distance between the plates is one-third the outside diameter of the pipe with the weld located 45 degrees from the line of direction of the applied force, without developing cracks.

(b) For butt-welded pipe over 2 inches in diameter, a section of pipe 6 inches long shall be flattened between parallel plates until the distance between the plates is 60 per cent of the outside diameter of the pipe with the weld located 45 degrees from the line of direction of the applied force, without developing cracks.

7. For pipe 2 inches or under in diameter, a sufficient length of pipe shall withstand being bent cold through 90 degrees around a cylindrical mandrel, the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld.

8. (a) Test specimens shall consist of sections cut from a pipe. They shall be smooth on the ends and free from burrs.

(b) Tension test specimens shall be longitudinal.

(c) All specimens shall be tested cold.

9. One of each of the tests specified in Sections 4, 6 and 7 may be made on a length in each lot of 500 or less, of each size. Each length shall be subjected to the hydrostatic test.

10. If the results of the physical tests of any lot do not conform to the requirements specified in Sections 4, 6 and 7, retests of two additional pipes shall be made, each of which shall conform to the requirements specified.

IV. STANDARD WEIGHTS.

11. (a) The standard weights for pipe of various inside diameters are given in Table II.

(b) Nipples shall be cut from pipe of the same weight and quality as described in these specifications.

*Criticism of these tentative specifications are solicited and should be directed, preferably before January 1, 1922, to Mr. F. M. Waring, chairman of Committee A-1 on Steel, Pennsylvania System, Altoona, Pa.

These specifications, when adopted as standard, will supersede the present standard specifications for welded steel pipe (serial designation: A 53-18), 1918 Book of A. S. T. M. standards.

Table I—Hydrostatic Pressures for Welded Steel Pipe.
(Pressures expressed in pounds per square inch.)
(Black and Galvanized)

Size (Nominal Inside Diameter), Inches	"Standard" Pipe			"Extra Strong" Pipe		
	Weight of Pipe per Linear Foot, Threaded and With Couplings, Pounds	Butt-Weld	Lap-Weld	Weight of Pipe per Linear Foot, Plain Ends, Pounds	Butt-Weld	Lap-Weld
1/8	....	700	....	....	700	....
1/4	....	700	....	....	700	....
3/8	....	700	....	....	700	....
1/2	....	700	....	....	700	....
3/4	....	700	....	....	700	....
1	....	700	....	....	700	....
1 1/4	....	700	1000	....	1500	2500
1 1/2	....	700	1000	....	1500	2500
2	....	700	1000	....	1500	2500
2 1/2	....	800	1000	....	1500	2000
3	....	800	1000	....	1500	2000
3 1/2	....	....	1000	....	....	2000
4	....	....	1000	....	....	2000
4 1/2	....	....	1000	....	....	1800
5	....	....	1000	....	....	1800
6	....	....	1000	....	....	1800
7	....	....	1000	....	....	1500
8	25.00	....	800	....	....	....
8	28.81	....	1000	43.39	....	1500
9	34.19	....	900	48.73	....	1200
10	32.00	....	600	....	....	....
10	35.00	....	700	....	....	....
10	41.13	....	900	54.74	....	1000
11	46.25	....	800	60.08	....	1000
12	45.00	....	600	....	....	....
12	50.71	....	800	65.42	....	1000

For pipes over 12 inches in inside diameter, the test pressure should be calculated by the formula $P = \frac{2 St}{D}$ in which
P = pressure in pounds per square inch; S = fiber stress = 12,000 pounds per square inch; t = thickness of wall in inches;
D = inside diameter in inches.

12. The weight of the pipe shall not vary more than 5 per cent from that specified in Table II.
13. Unless otherwise specified, pipe shall be furnished as to lengths in accordance with the following regular practice:

Table II—Standard Weights and Dimensions of Welded and Seamless Steel Pipe.
(Black and Galvanized)

Size (Nominal Inside Diameter), Inches	"Standard" Pipe				"Extra Strong" Pipe	
	Outside Diameter, Inches	Number of Threads Per Inch	Thickness Inches	Weight of Pipe Per Linear Foot, Threaded and With Couplings, Pounds	Thickness, Inches	Weight of Pipe Per Linear Foot, Plain Ends, Pounds
1/8	0.405	27	0.068	0.25	0.095	0.31
1/4	0.540	18	0.088	0.43	0.119	0.54
3/8	0.675	18	0.091	0.57	0.126	0.74
1/2	0.840	14	0.109	0.85	0.147	1.09
3/4	1.050	14	0.113	1.13	0.154	1.47
1	1.315	11 1/2	0.133	1.68	0.179	2.17
1 1/4	1.660	11 1/2	0.140	2.28	0.191	3.00
1 1/2	1.900	11 1/2	0.145	2.73	0.200	3.63
2	2.375	11 1/2	0.154	3.68	0.218	5.02
2 1/2	2.875	8	0.203	5.82	0.276	7.66
3	3.500	8	0.216	7.62	0.300	10.25
3 1/2	4.000	8	0.226	9.20	0.318	12.51
4	4.500	8	0.237	10.89	0.337	14.98
4 1/2	5.000	8	0.247	12.64	0.355	17.61
5	5.563	8	0.258	14.81	0.375	20.78
6	6.625	8	0.280	19.19	0.432	28.57
7	7.625	8	0.301	23.77	0.500	38.05
*8	8.625	8	0.277	25.00	....	....
8	8.625	8	0.322	28.81	0.500	43.39
9	9.625	8	0.342	34.19	0.500	48.73
*10	10.750	8	0.279	32.00	....	....
*10	10.750	8	0.307	35.00	....	....
10	10.750	8	0.365	41.13	0.500	54.74
11	11.750	8	0.375	46.25	0.500	60.08
*12	12.750	8	0.330	45.00	....	....
12	12.750	8	0.375	50.71	0.500	65.42

*Unless specifically stated on the order the lighter weights will not be furnished. Weights given in the table are for pipes up to and including 12 inches in nominal inside diameter, with threaded ends and couplings; sizes larger than those shown in the table are measured by the outside diameter and will be furnished with plain ends unless otherwise specified; for such sizes it will be necessary to accept manufacturers' weights or calculate the weights on the basis of one cubic inch of steel weighing 0.2833 pounds.

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(a) Standard pipe shall be in random lengths of 16 to 22 feet, but not more than 5 per cent of the total number of lengths may be "jointers," which are two pieces coupled together. When ordered with plain ends, 5 per cent may be in lengths of 12 to 16 feet.

(b) Extra strong pipe shall be in random lengths of 12 to 22 feet. Five per cent may be in lengths of 6 to 12 feet.

V. WORKMANSHIP AND FINISH.

14. For pipe $1\frac{1}{2}$ inches or under in inside diameter, the outside diameter at any point shall not vary more than $1/64$ inch over nor more than $1/32$ inch under the standard size. For pipe 2 inches or over in inside diameter, the outside diameter shall not vary more than 1 per cent over or under the standard size.

15. Unless otherwise specified, pipe shall conform to the following regular practice:

(a) Each end of standard welded pipe shall be threaded.

(b) Extra strong welded pipe and standard and extra strong seamless pipe shall be furnished with plain ends.

(c) All threads shall be in accordance with the American Standard* and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. The variation from the standard, when tested with the standard working gauge, shall not exceed a maximum of one and one-half turns either way.

(d) Each length of threaded pipe shall be provided with one coupling, having clean-cut threads of such a pitch diameter as to make a tight joint. Couplings may be made of wrought iron or steel.

16. The finished pipe shall be reasonably straight and free from injurious defects. All burrs at the ends of the pipe shall be removed.

VI. INSPECTION AND REJECTION.

17. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the pipe are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

18. Each length of pipe which develops injurious defects in shop working or application will be rejected, and the manufacturer shall be notified.

Proposed Tentative Specifications for Carbon-Steel Rails.†

I. MANUFACTURE.

1. The steel shall be made by the Bessemer or open-hearth process as specified by the purchaser. The

*A complete description of the American Standard Pipe Thread is contained in the Pipe Thread Standard prepared under the sponsorship of the American Gas Association and the American Society of Mechanical Engineers, and approved as American Standard by the American Engineering Standards Committee.

†Criticisms of these tentative specifications are solicited and should be directed, preferably before January 1, 1922, to Mr. F. M. Waring, chairman of Committee A-1 on Steel, Pennsylvania System, Altoona, Pa.

entire process of manufacture shall be in accordance with the best current practice.

2. There shall be sheared from the end of the bloom, formed from the top of the ingot, sufficient metal to secure sound rails.

3. The addition of aluminum to the molds shall not be permitted.

II. CHEMICAL PROPERTIES AND TESTS.

4. The steel shall conform to the following requirements as to chemical composition:

Elements Considered.	Bessemer Steel.	85-110 lb. per yd.
	70-84 lb. per yd.	Inclusive
Carbon, per cent.....	Inclusive 0.40 to 0.50	0.45 to 0.55
Manganese, per cent.....	0.80 to 1.10	0.80 to 1.10
Phosphorus, max. per cent.	0.10	0.10
Silicon, min. per cent.....	0.10	0.10
Open-Hearth Steel.		
Carbon, per cent.....	0.53 to 0.68	0.62 to 0.77
Manganese, per cent.....	0.60 to 0.90	0.60 to 0.90
Phosphorus, max. per cent.	0.04	0.04
Silicon, min. per cent.....	0.10	0.10

5. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

6. (a) To determine whether the material conforms to the requirements specified in Section 4, analyses shall be made as follows:

(b) For the Bessemer process analyses shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, sulphur and silicon. These analyses shall be made from drillings taken at least $\frac{1}{8}$ inch beneath the surface of a test ingot obtained during the pouring of the melt. The carbon content shall be reported for each melt, and two averages of the percentages of carbon, manganese, phosphorus, sulphur and silicon shall be reported to the inspector daily, one for each day and night turn, respectively.

(c) For the open-hearth process an analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, sulphur and silicon. This analysis shall be made from drillings taken longitudinally of the rail, using a $\frac{1}{2}$ -inch drill, close to an upper corner of the head from any one of the three drop-test pieces representing the top of the ingot or from pieces cut adjacent to any one of these three drop-test pieces. The chemical composition thus determined shall be reported to the inspector.

7. (a) An analysis may be made by the purchaser from a portion of the test ingot in the case of Bessemer steel or from a portion of the drillings from the finished rail in the case of the open-hearth steel, furnished by the manufacturer at the request of the inspector.

(b) When the analysis for carbon made by the manufacturer and the purchaser do not agree the limits for carbon specified in Section 4 shall be extended 0.02 below the minimum and 0.02 above the maximum to cover such variation before rejection of the material.

III. PHYSICAL PROPERTIES AND TESTS.

8. Tests shall be made to determine—

(a) Ductility or toughness as opposed to brittleness.

(b) Soundness.

9. The physical qualities shall be determined by the drop test.

10. (a) The drop-testing machine shall be the standard of the American Railway Engineering Association.

(b) The tup shall weigh 2,000 pounds and have a striking face with a radius of 5 inches.

(c) The anvil block shall weigh 20,000 pounds and be supported on springs.

(d) The supports for the test pieces shall be a part of, or firmly secured to, the anvil. These supports shall be spaced 3 feet between centers for rails 110 pounds per yard, or less in weight. The bearing surfaces of the supports shall have a radius of 5 inches.

11. (a) Drop tests shall be made on pieces of rail one or two feet longer than the span between the supports in the testing machine. These test pieces shall be cut from the crop of the top rail of the ingot and marked on the center line of the top surface of the head with gauge marks 1 inch apart for 3 inches each side of the center of the test piece for measuring the ductility of the metal.

(b) The temperature of the test piece when tested shall be between 60 and 100 degrees F.

(c) Where it is necessary to test rails lower than the first rail, the bottom of the first rail, in lieu of the top of the second rail, and the bottom of the second rail, in lieu of the top of the third rail, shall be accepted, if preferred by the manufacturer.

12. Unless otherwise specified, the test pieces shall be tested with the head in tension and with the center punch marks midway between the supports.

13. The test piece shall be subjected to impact of the tup falling free from the following heights:

Weight of Rail, Lb. Per Yd.	Height of Drop, Ft.
70-79 inclusive	16
80-90 inclusive	17
91-110 inclusive	18

14. (a) Under impacts, the rail under one or more blows shall show at least 8 per cent elongation for 1 inch of the 6-inch scale, marked as described in Section 11 (a).

(b) A sufficient number of blows shall be given to determine the complete elongation of the test piece of at least every fifth melt of Bessemer steel and of one out of every three test pieces of a melt of open-hearth steel.

15. For every specimen a record shall be made of the permanent set after each blow under the drop test as measured by the middle ordinate in a length of 3 feet.

16. Test pieces which do not break under the first or subsequent blows shall be nicked and broken to determine whether the interior metal is sound. The words "interior defect" in the following sections shall be interpreted to mean seams, laminations, cavities or interposed foreign matter made visible by the destruction tests, saws, or drills.

17. (a) One piece shall be tested from each melt of Bessemer steel.

(b) If the test piece shows the required elongation (Section 14) all the rails of the melt shall be accepted, provided that the test piece when broken shows no interior defect.

(c) If the test piece does not show the required elongation (Section 14) or, if when broken, shows interior defect, all of the top rails from that melt shall be rejected.

(d) A second test shall then be made of a test piece selected by the inspector from the top end of any second rail of the same melt, preferably of the same ingot. If the test piece shows the required elongation (Section 14) all the remaining rails of the melt shall be accepted, provided that the test piece when broken shows no interior defect.

(e) If the second piece does not show the required elongation (Section 14) or, if when broken, shows interior defect, all of the second rails from that melt shall be rejected.

(f) A third test shall then be made of a test piece selected by the inspector from the top end of any third rail of the same melt, preferably of the same ingot. If the test piece shows the required elongation (Section 14) all the remaining rails of the melt shall be accepted, provided that the test piece when broken shows no interior defect.

(g) If the third test piece does not show the required elongation (Section 14) or if when broken shows interior defect, all the remaining rails from that melt shall be rejected.

18. (a) Test pieces shall be selected from the second, middle and last full ingot of each open-hearth melt.

(b) If all of these test pieces, show the required elongation (Section 14) all of the rails of the melt shall be accepted, provided that no test piece when broken shows interior defect.

(c) If any test piece does not show the required elongation (Section 14) or, if when broken, shows interior defect, all of the top rails from that melt shall be rejected.

(d) A second test shall then be made from three test pieces selected by the inspector from the top end of any second rails of the same melt, preferably of the same ingots. If all of these test pieces show the required elongation (Section 14) all the remaining rails of the melt shall be accepted, provided that no test piece when broken shows interior defect.

(e) If any test piece does not show the required elongation (Section 14) or, if when broken, shows interior defect, all of the second rails of the melt shall be rejected.

(f) A third test shall then be made from three test pieces selected by the inspector from the top end of any third rails of the same melt, preferably of the same ingots. If all these test pieces show the required elongation (Section 14) all the remaining rails of the melt shall be accepted, provided that no test piece when broken shows interior defect.

(g) If any test piece does not show the required elongation (Section 14) or, if when broken, shows interior defect, all the remaining rails from the melt shall be rejected.

IV. STANDARD SECTION, LENGTH AND WEIGHT.

19. The section of rails shall conform as accurately as possible to the templet furnished by the purchaser. A variation in height of 1/64 inch less or 1/32 inch greater than the specified height and 1/16 inch in width of base, will be permitted; but no variation shall be allowed in the dimensions affecting the fit of the splice bars.

20. The standard length of rails shall be 33 feet at a temperature of 60 degrees F. Ten per cent of the entire order will be accepted in shorter lengths varying by 1 foot from 32 to 25 feet. A variation of 1/4

inch from the specified length will be allowed, excepting that for 15 per cent of the order a variation of $\frac{3}{8}$ inch from the specified lengths will be permitted.

21. (a) The weight of the rails per yard as specified in the order shall be maintained as nearly as possible after conforming to the requirements of Section 19.

(b) The total weight of an order shall vary not more than 0.5 per cent from the calculated weight of section.

(c) Payments shall be based upon actual weights.

V. WORKMANSHIP AND FINISH.

22. (a) Care shall be taken in cambering the rails and with the hot-bed work so that the rails will cool with a small but uniform sweep, and, therefore, gaging under the presses will be reduced to a minimum. Rails while on the cooling bed shall be protected from snow, water and excessive gusts of cold wind.

(b) Any rails delivered to the straightening presses showing sharp kinks or greater camber than that indicated by the middle ordinate of 4 inches in 33 feet for the R.E. and R.A. thick-base sections, or 5 inches for A.S.C.E. type of sections, will be at once classed as No. 2 rails.

(c) The distance between the supports of rails in the straightening presses shall be not less than 42 inches. The supports shall have flat surfaces and be out of wind. The application of the gag shall be central between the supports, and the overhang of either end of the rail during straightening shall be supported.

(d) Rails heard to snap or check while being straightened shall be at once rejected.

23. Circular holes for joint bolts shall be drilled to conform to the drawings and dimensions furnished by the purchaser. A variation of $\frac{1}{32}$ inch in the specified size and location of bolt holes will be allowed.

24. (a) All rails shall be smooth on the heads, straight in line and surface and without any twists, waves or kinks. They shall be sawed square at the ends, a variation of not more than $\frac{1}{32}$ inch being allowed and burrs shall be carefully removed.

(b) Rails improperly drilled or straightened, or from which the burrs have not been removed, shall be rejected, but may be accepted after being properly finished.

(c) When any finished rail shows interior defect at either end or in any drilled hole, the entire rail shall be rejected except that in the case of the bottom rails of the ingot, permission shall be given to cut back to sound metal.

VI. CLASSIFICATION OF RAILS.

25. No. 1 rails shall be free from injurious defects and flaws of all kinds.

26. (a) Rails which by reason of surface imperfections, or for causes mentioned in Section 22, vary from the specifications in a manner which does not impair their soundness and strength, will be accepted as No. 2 rails, but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment.

(b) No. 2 rails to the extent of 5 per cent of the whole order will be accepted.

VII. MARKING AND LOADING.

27. (a) The name of the manufacturer, the weight and type of section of rail, and the month and year of manufacture, shall be rolled in raised letters and figures on the side of the web. The type shall be marked by letters which signify the name by which it is known, for example:

Sections of American Society of Civil Engineers—A.S.C.E.

Sections of American Railroad Association—R.A.—A., R.A.—B.

Sections of American Railway Engineering Association—R.E.

(b) The number of the melt and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail where it will not be covered by the splice bars. The top rails shall be letter "A" and the succeeding ones "B," "C," "D," etc., consecutively, but in the case of a top discard of 20 to 35 per cent the letter "A" will be omitted, the top rail becoming "B." If the top discard be greater than 35 per cent, the letter "B" shall be omitted, the top rail becoming "C."

(c) Open-hearth rails shall be branded or stamped "O.H." in addition to the other marks.

(d) All marking of rails shall be done so effectively that the marks may be read as long as the rails are in service.

28. (a) All rails accepted as No. 2 rails shall have the ends painted white and shall have two prick-punch marks on the side of the web near the melt number near the end of the rail so placed as not to be covered by the splice bars.

(b) No. 1 rails less than 33 feet long shall have the ends painted green.

29. All classes of rails shall be kept separate from each other.

30. Rails shall be carefully handled and loaded in such manner as not to injure them.

VIII. INSPECTION.

31. The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Proposed Tentative Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement.*

1. These specifications cover cold-drawn steel wire to be used as such, or in fabricated form, for the reinforcement of concrete, in gauges not less than 0.080 inch, nor greater than 0.500 inch.

2. When wire is ordered by gauge number the following relation between number and diameter, in inches, shall apply unless otherwise specified:

*Criticisms of these tentative specifications are solicited and should be directed, preferably before January 1, 1922, to Mr. F. M. Waring, chairman of Committee A-1 on Steel, Pennsylvania System, Altoona, Pa.

Gage Number	Equivalent Diameter, In.	Gage Number	Equivalent Diameter, In.
0000000	0.4900	5	0.2070
000000	0.4615	6	0.1920
00000	0.4305	7	0.1770
0000	0.3938	8	0.1620
000	0.3625	9	0.1483
00	0.3310	10	0.1350
0	0.3065	11	0.1205
1	0.2830	12	0.1055
2	0.2625	13	0.0915
3	0.2437	14	0.0800
4	0.2253		

I. MANUFACTURE.

3. (a) The steel shall be made by either or both the following processes: Bessemer or open hearth.
(b) The wire shall be cold drawn from rods hot-rolled from billets.

II. PHYSICAL PROPERTIES AND TESTS.

4. (a) The wire, except as specified in paragraphs (b) and (c), shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	80,000
Reduction of area, per cent.	30

- (b) For wire to be used in the fabrication of mesh a minimum tensile strength of 70,000 pounds per square inch shall be permitted.
(c) For wire testing over 100,000 pounds per square inch tensile strength, the reduction of area shall be not less than 25 per cent.
5. The test specimen shall withstand being bent cold through 180 degrees without cracking on the outside of the bent portion, as follows:

- For wire 0.3 inch in diameter or under, around a pin the diameter of which is equal to the diameter of the specimen.
For wire over 0.3 inch in diameter, around a pin the diameter of which is equal to twice the diameter of the specimen.

6. Tension and bend test specimens shall be of the full-size section of the wire as drawn.
7. (a) One tension and one bend test shall be made for each 10 tons or less of each size of wire.
(b) If any test specimen shows defects or develops flaws, it may be discarded and another specimen substituted.

III. PERMISSIBLE VARIATIONS IN GAGE.

8. The diameter of the wire shall not vary more than 0.003 inch from the size ordered.

IV. WORKMANSHIP AND FINISH.

9. The finished wire shall be free from injurious defects and shall have a workmanlike finish with smooth surface.

V. INSPECTION AND REJECTION.

10. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the wire is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

11. Wire which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Proposed Tentative Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes.†

1. These specifications cover lap-welded and seamless steel and lap-welded iron boiler tubes, boiler flues, superheater tubes, safe ends and arch tubes.

I. MANUFACTURE.

2. (a) The material for lap-welded tubes shall be made by the open-hearth process, or by the knobbled, hammered charcoal iron process.
(b) The material for seamless tubes shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

3. (a) Chemical analysis will not be required for charcoal iron tubes.
(b) Material made by the open-hearth process shall conform to the following requirements as to chemical composition:

	Grade A.	Grade B.
Carbon, per cent.	0.08-0.18	not over 0.03
Manganese, per cent.	0.30-0.60	not over 0.03
Phosphorus, per cent.	not over 0.04	not over 0.02
Sulphur, per cent.	not over 0.045	not over 0.045

- (4. (a) Analyses of two tubes in each lot of 250 tubes or less, and of 2,000 feet or less of safe end material, may be made by the purchaser. The chemical composition thus determined shall conform to the requirements specified in Section 3 (b). Drillings for analysis shall be taken from several points around each tube.
(b) If the analysis of only one tube does not conform to the requirements specified, analyses of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

III. PHYSICAL PROPERTIES AND TESTS.

5. Tubes of material made by the open-hearth process shall meet the tests specified for steel tubes.
6. (a) For tubes not more than 6 inches in diameter and having a thickness less than 10 per cent of the outside diameter, provided the thickness does not exceed No. 6 B.w.g. (0.203 inches), a test specimen not less than 4 inches in length shall have a flange turned over at right angles to the body of the tube without cracking or showing any flaw. This flange, as measured from the outside of tube, shall in no case be less than 1/8 inch nor more than 1/2 inch. Within these limits the width of flange shall be not less than 10 per cent of the outside diameter for charcoal-iron, nor less than 15 per cent for steel tubes up to 2 1/2 inches, inclusive. For steel tubes over 2 1/2 inches in diameter and up to 3 3/4 inches the width of flange shall be 10 per cent of the outside diameter.
(b) For tubes not specified in Paragraph (a) the flange test will not be required.

7. (a) For all tubes, except when the wall thickness is in excess of 10 per cent of the outside diameter, providing the thickness does not exceed No. 6 B.w.g.

†Criticism of these tentative specifications are solicited and should be directed, preferably before January 1, 1922, to Mr. F. M. Waring, chairman of Committee A-1 on Steel, Pennsylvania System, Altoona, Pa.

(0.203 inches), a test specimen 3 inches in length shall withstand flattening between parallel plates, without cracking or showing any flaw, until the distance between the plates is as follows:

Three times the wall thickness for seamless tubes;

Five times the wall thickness for lap-welded tubes.

(b) For all tubes not specified in Paragraph (a) a test specimen 3 inches in length shall withstand flattening between parallel plates, without cracking or showing any flaw, until the distance between the plates is as follows:

Four times the wall thickness for seamless tubes;

Six times the wall thickness for lap-welded tubes.

8. When required by the inspector, crushing tests shall be made on test specimens $2\frac{1}{2}$ inches in length, which shall withstand crushing longitudinally, without cracking, splitting or opening at the weld, as follows:

Steel tubes: No. 10 B.w.g. or lighter to a height of $\frac{3}{4}$ inch, or until outside folds are in contact; if heavier than No. 10 B.w.g. to a height of $1\frac{1}{2}$ in.

Note—In the case of lap-welded tubes, the test shall be made with the weld at the point of maximum bend.

Note—In the case of lap-welded tubes, the test shall be made with the weld at the point of maximum bend.

Charcoal-iron tubes: No. 10 B.w.g. or lighter, to a height of $1\frac{1}{8}$ inches; if heavier than No. 10 B.w.g., to a height of $1\frac{3}{4}$ inches.

9. Tubes under 5 inches in diameter shall withstand an internal hydrostatic pressure of 1,000 pounds per square inch, and tubes 5 inches or over in diameter shall withstand an internal hydrostatic pressure of 800 pounds per square inch; provided that the fiber stress corresponding to these pressures does not exceed 16,000 pounds per square inch. Should the fiber stress corresponding to these pressures exceed 16,000 pounds per square inch, the test pressure shall be determined by the formula:

$$P = \frac{32,000 t}{D}$$

in which P = the pressure in pounds per square inch, t = the thickness of wall in inches, and D = the inside diameter of the tube in inches. Lap-welded tubes shall be struck near both ends, while under the test pressure, with a 2-pound steel hand hammer or the equivalent.

10. A cross-section of charcoal-iron tubes may be turned or ground to a true surface, polished free from dirt or cracks, and etched* until the soft parts are

*A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for etch test.

Table I—Standard Weights of Lap-Welded and Seamless Boiler Tubes.

Including safe ends, arch tubes and large boiler tubes.

Thickness—		Weight, Pounds Per Foot of Length—							Thickness—		Weight, Pounds Per Foot of Length—						
		Outside Diameter, Inches									Outside Diameter, Inches						
In.	B.w.g.	1 $\frac{3}{4}$	2	2 $\frac{1}{4}$	2 $\frac{1}{2}$	2 $\frac{3}{4}$	3		In.	B.w.g.	5 $\frac{1}{4}$	5 $\frac{3}{8}$	5 $\frac{1}{2}$	6	7	8	
0.095	13	1.679	1.932	2.186	2.440	2.694	2.948		0.095	13	.....	.....	.....	.....	.....	.....	
0.109	12	1.910	2.201	2.492	2.783	3.074	3.365		0.109	12	.....	.....	.....	.....	.....	.....	
0.120	11	2.089	2.409	2.729	3.050	3.370	3.691		0.120	11	.....	.....	.....	.....	.....	.....	
0.134	10	2.312	2.670	3.028	3.386	3.743	4.101		0.134	10	.....	.....	.....	.....	.....	.....	
0.148	9	2.532	2.927	3.322	3.717	4.112	4.508		0.148	9	8.064	8.262	8.459	.....	.....	.....	
0.165	8	.....	3.233	.....	4.114	4.555	4.995		0.165	8	8.960	9.181	9.401	10.282	12.044	13.807	
0.180	7	.....	.....	.....	4.460	4.940	5.421		0.180	7	9.746	9.987	10.227	11.188	13.110	15.033	
0.203	6	.....	.....	.....	4.980	5.522	6.064		0.203	6	.....	.....	.....	12.568	14.736	16.904	
0.220	5	.....	.....	.....	5.357	5.944	6.531		0.220	5	.....	.....	.....	13.580	15.930	18.280	
0.229	4 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....		0.229	4 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....	
0.238	4	.....	.....	.....	5.749	6.385	7.020		0.238	4	.....	.....	.....	14.646	17.188	19.730	
0.2485	3 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....		0.2485	3 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....	
0.259	3	.....	4.815	5.507	6.198	6.890	7.582		0.259	3	.....	.....	.....	.....	.....	.....	
0.2715	2 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....		0.2715	2 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....	
0.284	2	.....	.....	.....	6.721	.....	8.238		0.284	2	.....	.....	.....	.....	.....	.....	
0.292	1 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....		0.292	1 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....	
0.300	1	.....	.....	.....	7.048	7.849	8.650		0.300	1	.....	.....	.....	.....	.....	.....	
0.320	1 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....		0.320	1 $\frac{1}{2}$	.....	.....	.....	.....	.....	.....	
0.340	0	.....	.....	.....	.....	.....	.....		0.340	0	.....	.....	.....	.....	.....	.....	

Thickness—		Weight, Pounds Per Foot of Length—					Thickness—		Weight, Pounds Per Foot of Length—				
		Outside Diameter, Inches							Outside Diameter, Inches				
In.	B.w.g.	3 $\frac{1}{4}$	3 $\frac{1}{2}$	3 $\frac{3}{4}$	4	4 $\frac{1}{2}$	In.	B.w.g.	9	10	11	12	13
0.095	13	.....	.....	.....	.....	.....	0.095	13	.....	.....	.....	.....	.....
0.109	12	.....	.....	.....	.....	.....	0.109	12	.....	.....	.....	.....	.....
0.120	11	4.011	4.331	4.652	.....	.....	0.120	11	.....	.....	.....	.....	.....
0.134	10	4.459	4.817	5.175	5.532	6.248	0.134	10	.....	.....	.....	.....	.....
0.148	9	4.903	5.298	5.693	6.088	6.879	0.148	9	.....	.....	.....	.....	.....
0.165	8	5.436	5.877	6.317	6.758	7.639	0.165	8	.....	.....	.....	.....	.....
0.180	7	5.901	6.382	6.863	7.343	8.304	0.180	7	16.955	.....	.....	.....	.....
0.203	6	6.606	.....	.....	8.232	9.316	0.203	6	19.072	21.240	.....	.....	.....
0.220	5	7.119	.....	.....	.....	.....	0.220	5	20.629	22.979	25.329	.....	.....
0.229	4 $\frac{1}{2}$	.....	.....	.....	.....	.....	0.229	4 $\frac{1}{2}$	.....	.....	.....	28.788	.....
0.238	4	7.656	.....	.....	.....	.....	0.238	4	22.271	24.813	27.355	.....	32.439
0.2485	3 $\frac{1}{2}$	.....	.....	.....	.....	.....	0.2485	3 $\frac{1}{2}$	.....	.....	.....	31.188	.....
0.259	3	8.273	8.965	.....	.....	.....	0.259	3	24.179	26.945	29.711	.....	35.243
0.2715	2 $\frac{1}{2}$	.....	.....	.....	.....	.....	0.2715	2 $\frac{1}{2}$	.....	.....	.....	34.008	.....
0.284	2	8.996	9.754	.....	.....	.....	0.284	2	.....	29.470	32.503	.....	38.569
0.292	1 $\frac{1}{2}$	.....	.....	.....	.....	.....	0.292	1 $\frac{1}{2}$	.....	.....	.....	36.512	.....
0.300	1	9.451	10.252	.....	.....	.....	0.300	1	.....	.....	34.283	.....	40.69
0.320	1 $\frac{1}{2}$	.....	.....	.....	.....	.....	0.320	1 $\frac{1}{2}$	.....	.....	.....	39.918	.....
0.340	0	.....	.....	.....	.....	.....	0.340	0	.....	.....	.....	.....	45.971

Note—Seamless tubes are at present not available above 6 inches in outside diameter.

sufficiently dissolved for the iron tube to show a decided ridged surface, with the weld very distinct, while a steel tube would show a homogeneous surface.

11. Test specimens shall be taken from finished tubes. They shall be smooth on the ends and free from burrs. All specimens shall be tested cold.

12. Each tube shall be subjected to the hydrostatic test. One of each of the physical tests specified shall be made from each of two tubes in each lot of 250 or less, and each 2,000 feet or less of safe end material.

Table II—Standard Weights of Small Superheater Tubes.

Seamless Only.

—Thickness—		—Weight, Pounds Per Foot of Length—					
In.	B.w.g.	Outside Diameter, Inches					
		5/8	11/16	3/4	13/16	7/8	15/16
0.083	14	0.480	0.535	.....	.....	.....	.....
0.095	13	0.537	0.601	0.664	0.727	.....	.....
0.109	12	.....	.....	0.746	0.818	0.891	.....
0.120	11	.....	.....	.....	0.887	0.967	1.047
0.134	10	.....	.....	.....	.....	1.060	1.149
0.148	9	.....	.....	.....	.....	.....	1.247
0.165	8	.....	.....	.....	.....	.....	.....

15. The weight of any tube shall not be less than that shown in Tables Nos. I and II.

V. WORKMANSHIP AND FINISH.

16. (a) Finished tubes 4 inches or under in outside diameter shall be circular within 0.02 inches, and the mean outside diameter shall not vary more than 0.015 inches from the size ordered. For tubes over 4 inches in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter.

(b) Tubes shall be gauged with a Birmingham wire gauge, and shall be not less than the thickness specified, except that tubes will be accepted on which the gauge will go on tightly at the thinnest point.

(c) Cold-drawn tubes shall not, at any place, exceed the specified thickness by more than two gauges.

(d) Hot-finished tubes shall not, at any place, exceed the specified thickness by more than three gauges.

(e) The length shall not be less but may be 3/16 inch more than that specified.

17. Finished tubes shall be free from injurious defects and distortion, shall have smooth ends free from burrs and shall have a workmanlike finish.

VI. MARKING.

18. The name or brand of the manufacturer, the material from which it is made, whether steel or iron, and the pressure in pounds at which it was tested, shall be legibly stenciled on each tube.

VII. INSPECTION AND REJECTION.

19. (a) Unless otherwise specified, inspection and all tests, except check analyses, shall be made at the place of manufacture. When required, the manufacturer shall furnish the purchaser of each lot of tubes a statement as to the kind of material of which the tubes are made and that the tubes have been tested and have met all the requirements of these specifications.

(b) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the tubes ordered. The manufacturer

13. If the results of the physical tests of only one tube from any lot do not conform to the requirements specified in Sections 6, 7 and 8, retests of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

IV. STANDARD WEIGHTS.

14. The standard weights for tubes of various outside diameters and thicknesses are as indicated in Tables Nos. I and II.

—Thickness—		—Weight, Pounds Per Foot of Length—					
In.	B.w.g.	Outside Diameter, Inches					
		1	1 1/4	1 3/8	1 7/16	1 1/2	1 5/8
0.083	14	.....	.....	.....	.....	.....	.....
0.095	13	.....	.....	.....	.....	.....	.....
0.109	12	.....	.....	.....	.....	.....	.....
0.120	11	1.127	.....	.....	.....	.....	.....
0.134	10	1.239	1.597	1.776	1.865	1.954	2.133
0.148	9	1.346	1.741	1.939	2.038	2.138	2.334
0.165	8	.....	.....	.....	.....	2.352	.....

shall afford the inspector, without charge, all reasonable facilities to satisfy him that the tubes are being furnished in accordance with these specifications.

20. (a) Unless otherwise specified, any rejection based on tests made in accordance with Section 4 (a) shall be reported within five working days from the receipt of samples.

(b) Tubes when inserted in the boiler shall stand expanding and heading without showing cracks or flaws, or opening at the weld. Superheater tubes when properly manipulated shall stand all forging, welding, and bending operations necessary for application without developing defects. Tubes which fail in any of the above operations will be rejected, and the manufacturer shall be notified.

21. Samples tested in accordance with Section 4 (a) which represent rejected tubes, shall be preserved for two weeks from the date of test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

PRIZE FOR BEST DESIGN OF AN APPARATUS TO DETERMINE HARDNESS OF METALS

Sir Robert Hadfield, to whom the John Fritz Medal for his invention of manganese steel will be presented at the opening meeting of the British Institution of Civil Engineers on June 29, has offered a prize for the best design of an apparatus to determine the hardness of material accurately and suitable for application in metallurgical work for cases in which present methods partially fail, according to an announcement just made here by the American Society of Mechanical Engineers.

The award or awards, which are offered through the Institution of Mechanical Engineers of Great Britain, will be made by the Council of the Institution. The present funds amount to 154 pounds sterling. All communications submitted for the prize should be accompanied by scale drawings or by models or examples of the apparatus, and should reach the secretary of the Institution by December 1, 1921.



New Diamond Valv-in-Head Soot Blower

One of the Greatest Advance Steps Ever Made In the Soot Blowing Field Has Now Been Made by the Adoption of the New Valv-in-Head Soot Blower.

By ROBERT JUNE.

AN entirely new principle has been introduced in soot blower design. The valve, controlling the individual unit, has been incorporated as an integral part of the head. The resultant operating economies are, of course, tremendous. Indeed, it seems safe to say that this is the greatest advance so far made in the soot blower field.

Let us for a moment briefly review recent developments in this important branch of power plant prac-

every boiler plant. The situation has called for systematic study of every factor affecting combustion. This analysis has proved the mechanical soot blower to be one of the best paying investments in the boiler room.

It has been demonstrated by dozens of tests and by practical experience in thousands of plants that mechanical soot blowers will, on the average, effect such important economies as—a saving of 4 to 6 per cent in fuel—an increase in over-all efficiency of 3 to

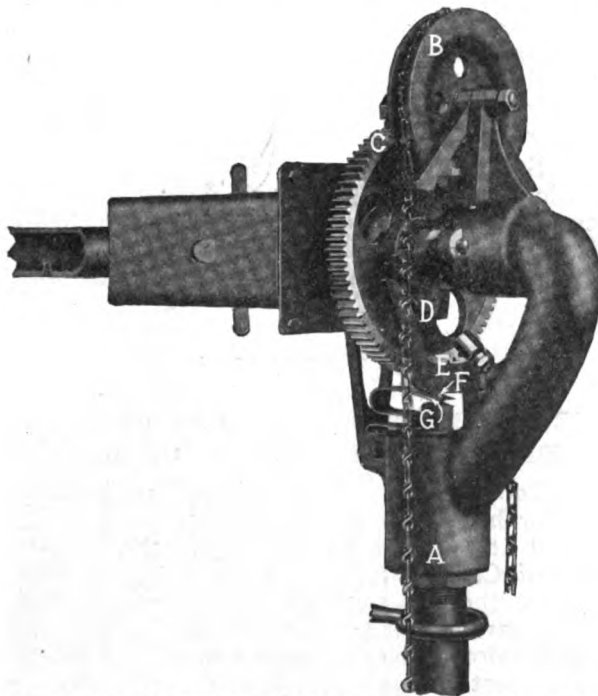


Fig. 1—Assembled Valv-in-Head unit. A—Location of valve in gooseneck. B—Sheave wheel. C—Gear. D—Cam. E—Lever. F—Valve stem. G—Spring.

tice. The past few years have witnessed, on the part of engineers everywhere, a marked growth in appreciation of the importance of rapid, thorough, mechanical removal of soot from the heating surfaces of steam generators. Coal and labor have constantly advanced in price. At the same time there have been unprecedented demands upon the boiler capacity of practically

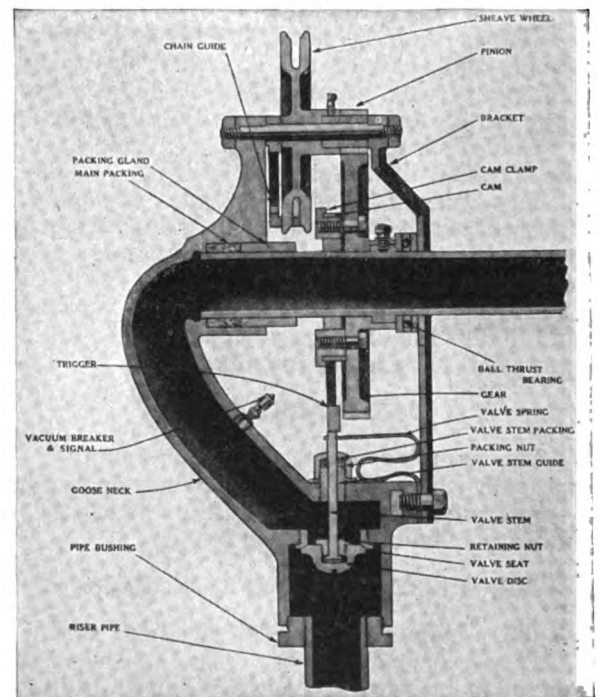


Fig. 2—Cross section of Diamond Valv-in-Head soot blower.

4 per cent—a decrease in consumption of steam required for cleaning, and—a marked saving in labor and labor turnover.

In view of these economies, it is not surprising to find that the largest manufacturer of soot blowers has been installing its equipment for several years at the rate of 2,500,000 hp annually.

A large measure of the success of the mechanical soot blower has been due to the constant improvement in design and construction. Among the improvements of the past few years are the following:

1. The introduction of calorized metal for the protection of the blower elements from oxidation at high temperatures.

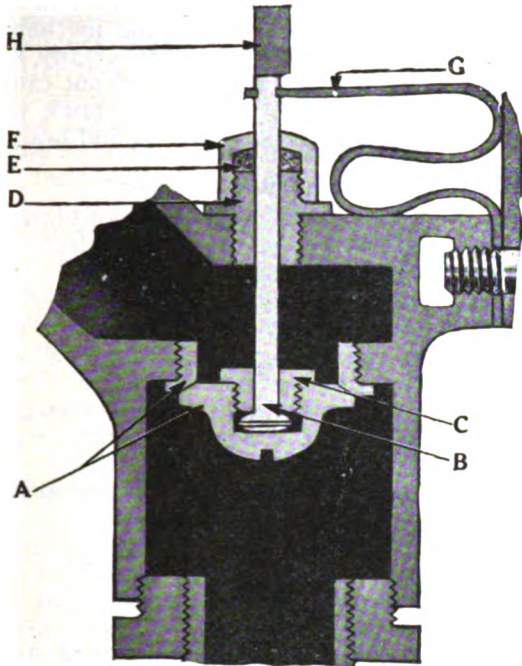


Fig. 3—Cross section of valve. A—Monel metal seat and disc. B—Nickel steel stem. C—Nickel steel retaining nut. D—Brass valve stem guide. E—Packing. F—Nut. G—Spring. H—Trigger.

2. The adaptation of nozzles of a Venturi section to secure the highest possible velocity of the steam jets.

3. The development of special processes for welding these nozzles in place.

4. The designing of steel bearings to support the blower elements.

5. The introduction of the vertical header system of piping.

The successes heretofore registered have proved a spur to further effects. Hence, we have the new Valv-in-Head soot blower, manufactured by the Diamond Power Specialty Company of Detroit, Mich.

Head Constructed on New Principle.

The Valv-in-Head soot blower is provided with a special monel valve of the poppet type, placed at the base of the gooseneck. This valve takes the place of the globe valve which has always heretofore been installed (at a distance of two to fifteen feet or more from the head) in the riser pipe leading from the main header.

The special valve just referred to is located at the point marked "A" in the illustration Fig. 1.

The unit is operated in the following manner: The main control and drain valves, which are the only independent valves on the soot blower line, having first been opened, and all pipes drained and heated, dry steam fills the line to the entrance of the individual valve at the base of the gooseneck "A." The sheave wheel "B" is then revolved by pulling the chain. This

turns a small steel cut pinion gear (not visible in the illustration). The small pinion engages the large gear "C" which is fixedly mounted on the blower element. As the gear is revolved, it operates the cam "D," which causes the lever "E" to press down the steam stem "F," causing the valve to open at a pre-determined point in the revolution. After the gear has been further rotated, the cam "D" releases the lever "E," allowing the steam pressure to close the valve at a second pre-determined point in the revolution. As steam leaves the line, the spring "G" holds the valve closed.

Construction of Valve.

The valve is made with Monel metal disc seat. Both the stem and its retaining nut are made of nickel steel. In order to secure extra hardness, which insures durability, the end of the stem is heat treated. A special feature is the provision of a guide on the seat which permits leaving the stem loose in the disc so that the valve will always seat properly. The entire construction is such that the troubles common to globe valves, such as "wire-drawing," leakage, etc., are almost entirely eliminated. Disc and seat are readily accessible so that they may be removed easily for re-grinding or renewal, should occasion ever require.

As the tendency toward high pressure and super-heat is very marked in modern power plant design, the company manufactures a special body Valv-in-Head soot blower for such boilers as require this type of equipment.

Cam and Lever Construction.

The movement of the cam is positive, assuring complete automatic opening of the valve at each operation. The cam and the clamps which hold it in place are

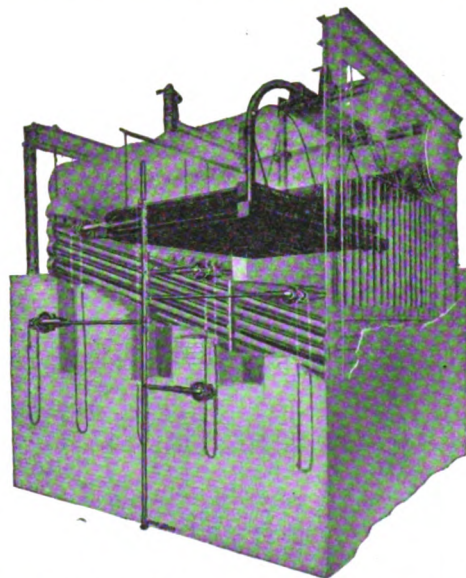


Fig. 4—Application of Diamond Valv-in-Head soot blower system to horizontal water tube boiler, vertically baffled. Basic principles and all features of the Valv-in-Head blower covered by patents issued and pending.

made of steel. The length and relative position of the cam is individually determined for each unit at the time of the installation.

The valve lever, which is also made of steel, is designed with a ratio of two to one, and, as the reduction of the gears is ten to one, the opening of the valve

is as readily accomplished as if a lever with a power arm of one hundred inches and a resistance of five inches were used. The spring is made of chrome vanadium. As the spring is away from heat, it always keeps its tension.

Vacuum Breaker and Signal.

A very unique idea has been worked out in the Valv-in-Head blower. Each head is provided with a vacuum breaker for the purpose of preventing the suction of furnace gases into the blower element during the periods when steam is off the unit. In the present head, this vacuum breaker has been designed in the form of a small brass whistle.

During the time that the soot blower is in operation, the whistle sounds, furnishing both an audible and a visible signal, so that there is no opportunity for the operator to leave steam on the unit for a moment during which he is not revolving the blower, without the fact becoming readily apparent to any one in the vicinity.

Chain Guides.

An important feature of the Valv-in-Head blower is the provision of guides to prevent the chain from slipping off the sheave wheel. It is not always convenient for the operator to stand directly under the unit, and the use of the chain guides enables him to operate the blower from any convenient point without facing the possibility of having to hunt up a ladder in order to replace the chain on the sheave. The chain guides, in common with many other parts of the head, are made of steel.

Ball Thrust Bearings.

A very marked step forward has been taken in the design of the Valv-in-Head soot blower through the provision of a ball bearing to relieve the friction caused by the thrust of the unit, due to steam. As will be seen from the cross section of the head, this ball thrust bearing is located directly back of the steel wall bracket which supports the blower element. Its presence re-

lieves the friction so completely that the Valv-in-Head unit turns as readily when the steam is on as when off.

Floating Features of Valv-in-Head.

The necessity for some means of eliminating the binding of soot blower units resulting from movement of the boiler tubes under the forces of expansion and contraction, is now generally recognized. An important development in connection with the Valv-in-Head soot blower is the wall box, with floating mechanism, which provides a means of taking care of any shifting of position of the blower element without causing dislocation of the wall box, cracking of brick work, or expansion strains on soot blower head and brackets.

Advantage of Valv-in-Head Soot Blower.

The advantage of the Valv-in-Head soot blower as compared to soot blowers of the independent valve type, fall into two general groups:

1. Labor—a saving of approximately 50 per cent.
2. Steam—a saving of 20 to 50 per cent or more.
3. Pipe, valves and fittings—a saving of 50 to 66 per cent in cost of pipe, valves and fittings.
4. Maintenance—a reduction in annual charges of 25 to 50 per cent or more. Practically complete elimination of condensate obtained.
5. Efficiency—greater cleanliness of boiler assured.

Indirect Economic Advantages.

The following advantages, while primarily of a mechanical nature, have an important dollars and cents value.

6. Interchangeability—especially adapted to replace other blower heads.
7. One model standard—head is made in one size for all boilers.
8. Control—steam may be intermittently discharged over two or more arcs in revolution. Arc or arcs of steam jets within boiler invariably cover exact pre-determined limits. Speed at which blower element may be revolved is so controlled by reduction gearing as to make improper operation extremely unlikely.

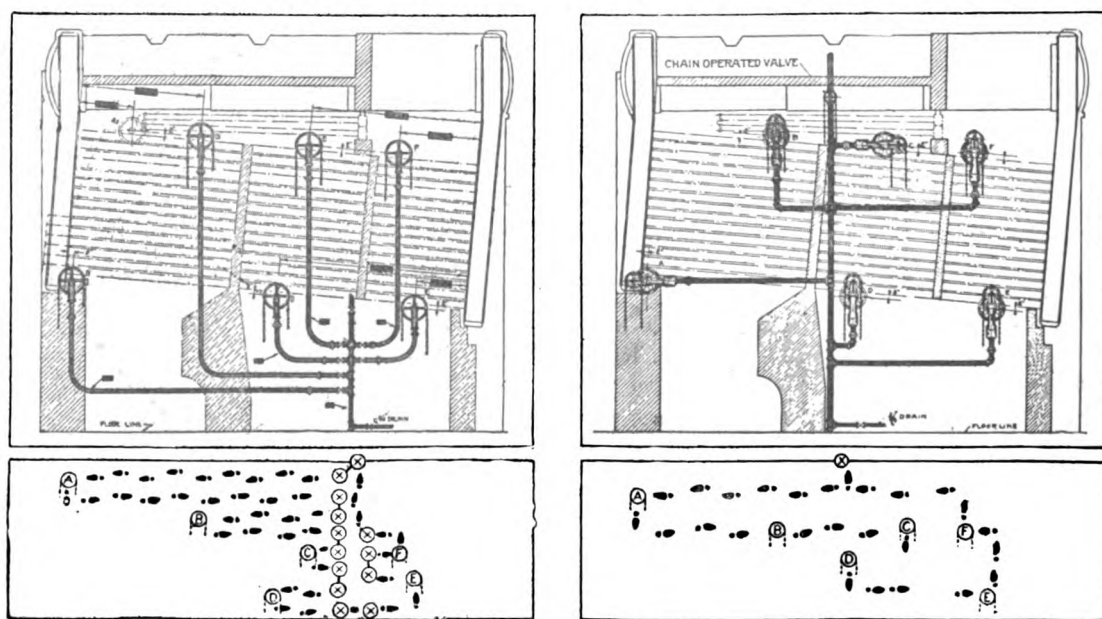


Fig. 5—Saving steps saves steam. The operator of the independent valve system at the left must retrace his steps as shown. Steam is discharged and wasted all the time he is in motion. With the Valv-in-Head system at the right the operator makes a single round trip. No steam whatever is discharged while he is in motion.

Unit provided with visible and audible signal to indicate valve open.

9. One—direction operation—revolution is always clockwise; hence, blower element cannot work loose from head either partially or entirely.

10. Ease of operation—gearing and ball thrust bearings overcome friction.

11. Valve design—time of opening and closing exactly adjusted to soot blower operating conditions, being slower than the standard quick-opening valve and faster than the standard globe valve, thus solving a problem of long standing. Quick-opening valves have the advantage of causing a sharp thrust of the unit, due to rapid admission of the steam. With globe valves, the tortuous passages cause marked reductions in effective pressure. There are also losses of time and of steam, from the slow opening and closing—losses which seem of small amount as respects a single operation, but which become important when spread over a period of time and a number of boilers.

Elimination of Condensate.

One of the most important results of the use of the Valv-in-Head blower is the practical elimination of the possibility of water entering the portion of the soot blower inside the boiler. With the independent valve type of soot blower, the valve is located anywhere from 2 to 15 feet or more from the head. This means that condensation will inevitably take place when the valve is admitted to the cold line. The water thus formed is driven through the soot blower head and into the blower element.

In addition to the condensate thus formed in the line, a more serious possibility is that a small leak in the valve will cause water to form in the pipe before the valve is opened. When this occurs, a solid column of water may be built up in the riser pipes and carried over into the boiler when the valve is opened.

The presence of this condensate in the hot blower element is apt to cause warping, and its discharge on the boiler tubes may cause the soot to pack, forming a gummy mixture hard to remove.

With the Valv-in-Head system, any condensate in the main supply line is discharged through the drain pipes before blowing begins. There is, therefore, no water below the valve which can be carried into the blower head, and the radiation area in the head itself is so small as to be negligible. Hence we have practically complete elimination of condensate from the blower element.

Saving of Labor and Steam.

With the Valv-in-Head system, the length of time of blowing is cut squarely in half. There is no walking back and forth from chain to valve. A single round trip completes the cycle of operations. This effects a marked saving in labor.

Furthermore, a saving in steam of 20 to 50 per cent or more is effected. This saving is a result of the cutting down of losses which occur with the independent valve system when the operator walks back and forth from valve to unit, steam being discharged all the time the man is in motion. Steam is also saved as a result of the Valv-in-Head blower being designed for operation at a pre-determined speed, as this has a marked effect in producing regularity of operation, the

blower never being left open longer than the time actually required.

Greater Cleaning Efficiency.

A very marked advantage in the use of the Valv-in-Head soot blower is the increase in effective pressure in the blower element. This is due to two factors. First, the valve offers practically straight passage to the steam, whereas, the steam must take two right-angle turns through the globe valves, which causes an appreciable drop in pressure. Second, the Valv-in-Head system requires about half the quantity of pipe and fittings used with other blowers, and on this account the pressure drop from source of steam to blower element is very much less.

The outstanding advantage of this increase in effective pressure is, of course, the increase in cleaning efficiency of the steam jets. With increased velocity, the range of the steam jets is considerably greater, and the boiler is more thoroughly cleaned in all respects.

Control of Direction of Jets.

One of the results achieved by this design is the positive control of the direction of the steam jets within the boiler. The jets blow only when the nozzles are directed at parts of the boiler from which deposits of soot must be removed. The steam is automatically cut off from the blower element at the precise point in the revolution of the blower element at which the jets would begin to strike the baffles or other parts which might possibly be affected by contact with the live steam.

A striking advantage is that the cam may be so constructed as to permit blowing of the unit at two or more arcs in the revolution. This means that steam may be cut off when the jets approach a baffle, and turned on again when the baffle is passed.

With oil-fired boilers, this ability to control the arc of the steam jets is a particularly valuable feature, since it makes possible the avoidance of interference with draft, to the detriment of combustion.

Gear Reduction Assures Proper Speed of Rotation.

Heretofore it has been a problem to regulate the methods of blowing used by individual members of the boiler room crew. Where one fireman would operate the blowers slowly and in accordance with directions, the next one would yank the chain, spin the blower around and consider that he had done a thorough job of cleaning.

Actually, of course, the boilers are only effectively cleaned when the steam jets play on the tubes for a pre-determined period of time. The gear reduction arrangement provides for the revolution of the soot blower element at a speed regulated to conform to the proper length of time for blowing.

Saving in Pipes, Valves and Fittings.

With the Valv-in-Head soot blower system, a saving is effected of practically two-thirds in the actual length of pipe required.

In Tables I and II, there are given comparative bills of material on a vertical boiler of the Stirling type, for a six-unit soot blower installation of the independent valve system, and the Valv-in-Head system.

Table I.

Bill of Material Independent Valve System
Six-Unit Stirling Independent.

1	2½"	Main control valve.....	\$ 36.01
6	2"	Individual valves at \$24.28.....	145.56
3	¾"	Drain valve, bushing and nipple.....	6.38
28.5'	2½"	Pipe for main line at \$.461.....	13.15
9	2½"	Unions, ells, crosses, tees.....	11.39
83'	2"	Pipe for individual risers at \$.302.....	25.07
12	2"	Unions at \$.99.....	11.88

\$249.44

Prices as of May 1, 1921.

Note—Above estimate based on "bronze body valves, nickel seats and discs for pressures of 250 pounds."

For "all steel fittings, with steel body valves, nickel seats and discs" cost would be \$404.30.

Table II.

Bill of Material Valv-in-Head System
Six-Unit Stirling Installation.

1	2¾"	Main control valve, with 35' operating chain.....	\$45.01
1	¾"	Drain valve, bushing and nipple.....	6.38
27'	2½"	Pipe for main line at \$.461.....	12.45
11	2½"	Tees, unions, ells, etc.....	12.16
25'	2"	Pipe for individual risers at \$.302.....	7.60
9	2"	Union, ells.....	7.25

\$90.83

Prices as of May 1, 1921.

Note—Above estimate based on "bronze body valves, nickel seats and discs for pressures of 250 pounds."

For "all steel fittings, with steel body valves, nickel seats and discs," would cost \$164.82.

With this six-unit installation, the saving in cost of pipe valves and fittings effected by the Valv-in-Head system is approximately 64 per cent. The comparisons are:

Using "Bronze Body Valves, Nickel Seats and Discs."

Independent valve system.....	\$249.44
Valv-in-Head system.....	90.83

Saving by latter.....\$158.61

Using "All Steel Fittings, Steel Body Valves, Nickel Seats and Discs."

Independent valve system.....	\$404.30
Valv-in-Head system.....	164.82

Saving by latter.....\$239.48

Even should very cheap valves be used, the savings effected by the Valv-in-Head system would amount to 50 per cent.

Future Assured.

The Valv-in-Head soot blower presents so many striking advantages that its future is assured. Indeed, it opens a new page in the history of power plant development.

Modern Steel Works Power Plant

In These Days When Economical Production Is Such a Main Issue In Manufacture of Steel, Power Plants Offer Such Possibilities of Saving That They Must Be Carefully Considered.

By **W. N. FLANNIGAN,***

Steam Engineer, Ohio Works, Carnegie Steel Company.

PART III.

SINCE the boiler has a certain range, the same as any piece of equipment, over which it is efficient, and at abnormal loads or underloads, is inefficient, the hand method of forcing the boiler when the pressure drops and ceasing firing when the pressure rises could not be very economical. Even if equipped with instruments the best economy cannot be obtained by hand since instruments do not regulate or anticipate events, but merely indicate or record conditions after they have happened. This does not belittle instruments as they are also valuable.

Stokers are the equivalent of the automatic valve gear of an engine or the blading of a turbine and assist in obtaining economy, capacity and uniformity. An automatic combustion control system for boilers is the same as the governor on an engine or turbine and just as necessary if fuel is to be burned economically, fluctuations followed and each boiler is to carry its share of the load. With proper automatic control each boiler is compelled to carry its share of the load and the boilers to operate together in parallel the same as electric generators. The load can be proportioned among the boilers as desired to obtain best operating efficiency and reliability.

A good control system is one which will supply fuel, air at the right pressure, and draft to carry away prod-

ucts of combustion, in exact proportion to the load all through the range of operation and which will vary the above at the exact instant at which the load changes occur, not several minutes later. While numerous attempts at automatic control have been made for years, it is only lately that systems have been devised and perfected which can coördinate and control the operation of boilers with any degree of exactness. The latest system uses dc motor driven auxiliaries and, by handling only a quarter of one per cent of the total current used, controls the operation of the boiler with electrical precision and controls it directly by changing fuel and air supply in proper relation and in proportion to the load as changes occur, thus preventing inefficient operation and not merely correcting it after it has occurred. The dampers or induced draft fans in modern installations are now so controlled that the least possible draft necessary to carry away the products of combustion is used, thus reducing air leakage losses to a minimum, but at the same time avoiding a positive pressure in the combustion chamber which forces hot gases and flame into the brickwork causing deterioration.

The savings to be effected in the boiler room are so great that even with automatic control and stokers a good man should be used in the boiler room just as a good engineer is needed in the engine room in spite of automatic valve gear, governors, and safety stops on the engines or turbines.

*Paper delivered before American Iron and Steel Institute, New York, May 28.

The control systems in a large boiler plant pay close to 100 per cent on the investment in the saving of labor alone as the men are left free to watch the fires and not to act as governors, which results in better fires with fewer men. Likewise, since conditions are corrected as they occur, the fires seldom get into bad shape and high efficiency is continuous.

On account of ease of control, close regulation and the constant speed characteristics obtainable in a motor, as well as better regulation of feed water temperature and economical regulation of exhaust steam supply, motor driven auxiliaries are being widely used. The current for the auxiliaries is usually supplied from a house turbine which exhausts into the feed water heater.

Up to the last year or two ac motors were used, chiefly because the main units were usually ac, and besides furnishing an auxiliary source of power they furnished a means of varying the load on the house turbine and thus the supply of exhaust steam. However, due to the possibilities of electrical boiler control and the wide speed range and desirable characteristics of dc motors, direct current is now being used for auxiliary drive.

Practically every system of control yet devised has been tried in the steel works power plant and every system on the market today is in operation in at least one steel works. The largest part of the development of boiler control has been done in the steel works of this country, urged not only by variable load and desire for economy, but also by adverse labor conditions.

Instrument.

No one would operate a large electric generator without meters to show the voltage, amperes, frequency, power factor, etc., or without indicating and recording or integrating wattmeters, yet boilers and turbines have been operated by hand without any indication of what is going on in them. This attitude was due to two causes: ignorance or lack of interest on the part of the operators, but principally to lack of reliable instruments for making and recording the necessary measurements in boiler operation. The demand for such instruments and their fairly widespread adoption in modern power plants has resulted in a fairly reliable and rugged line of instruments for indicating and recording temperatures, steam, air and water flow, and pressures. Even instruments for automatic flue gas analysis have been greatly improved.

Instruments do not make boiler or turbine efficiency, but paying heed to their indications and warnings does. Practically every modern boiler and turbine installation is provided with flow meters, venturi meters for water, stack and steam temperature thermometers, draft gauges, and in many cases with CO₂ recorders in addition to the original and ever necessary instrument, the steam gauge.

The use of recording instruments is widespread as they not only show the operators the conditions as they occur and enable defects to be immediately corrected, but also show the executives comparative figures from day to day and enable large losses to be stopped at once. One per cent difference in efficiency will pay in less than a year for all of the instruments that can be applied to a 1,000 hp boiler, but without instruments the boiler might run for months at 10 per cent decrease in efficiency without anyone being the wiser unless coal bills were carefully checked. Even then an expensive campaign would have to be started to find the cause of the decrease.

There are very few power plants that will show more attention paid to instruments than is the case in the

modern steel works power plant, and this applies not only to the boiler house, but to the engine room and to the electrical equipment as well.

Stack and Fans.

For the average boiler at ordinary ratings without economizers an induced draft fan installation requires about the same investment as a good self supporting stack. However, the power and maintenance costs more than swing the balance in favor of the stack. As the boiler ratings increase or economizers are installed, and with very high horizontal tube boilers, the cost of the stack becomes abnormally large while the cost of the fan installation increases slowly. Therefore, even with the power and maintenance charges the fan becomes the better investment. With ordinary types of boilers the turning point is somewhere around 300 per cent maximum rating. Representative installations both of fans and of stacks are to be found in steel works power plants, fans being used both with and without economizers.

Unlined steel stacks and guyed stacks are practically a thing of the past in steel works power plants. Breechings and flues are also lined, either with brick or with a comparatively thin prepared asbestos lining. Concrete and brick stacks were brought to steel works by the coke plants on account of their corrosion resisting properties. The concrete stack after several years of trial has proven to be very satisfactory, and due to its reasonable first cost and freedom from maintenance is to be found in many power plants.

Coal and Ash Handling.

Coal and ash handling machinery in the boiler house is usually a specialized form of hoisting and conveying machinery and is fairly well standardized. The most notable features in the latest plants are the widespread use of belt conveyors, the reliability attained by them, provision for thorough mixing of coal and coke breeze in some plants, and the installation of boilers at such an elevation that standard railway cars can be run directly under the ash pits. Large sliding ash gates, air operated, are usually installed so that poking or bridging of ashes and clinker is eliminated. It is not economy to tie an expensive boiler house up to an unreliable coal or ash handling system and the elevated building scheme is certainly the most reliable ash handling system possible, as there is nothing to get out of order or to be operated, except the ash gates, and even if one does not work, the ash pit can be practically emptied by the other gates, since two or more are usually installed under each boiler. It is a difficult matter to show beforehand the exact saving by elevating the boilers and using standard railway cars for ash, but with all of the companies that have, or have had various systems in operation, this system is adopted as standard, and practically no other is considered for stoker fired central stations or steel works boiler houses unless local conditions seriously interfere.

Water Softening.

Many steel works lose yearly, due to dirty feed water, the cost of a good water softening plant. This statement at first appears questionable, but will bear considerable attention. Aside from the loss of efficiency due to scale, which fact no one questions although authorities disagree as to the amount, there is a high labor charge in cleaning and repairing and considerable loss of tubes, even if the water contains no corrosive substances. There is also a fuel loss in heating up boilers and deterioration of the settings due to shutdowns. In addition there is an in-

vestment in spare boilers which are necessary to permit others being cleaned and repaired, and which could be decreased if good feed water were available. Not all of the above loss can be saved by a water softening plant, because it is impossible to completely purify the water and they cost something to run, but the largest part of the amount can be readily saved.

The saving due to clean feed water does not end in the boiler house, but extends throughout the entire plant as clean feed water means cleaner steam and its freedom from powder and dirt, which scores engine cylinders, causes leaky valves and reduces turbine efficiency.

The cost of clean feed water can be written off the books on either of two entirely different accounts. The first has been mentioned, the second is safety. Large investments are being made for safety and no industry has made greater progress than the iron and steel industry. A water softening plant is one of the best safety installations that can be made, and is rapidly being recognized as such. Modern boilers from which high ratings are expected have to meet more severe conditions than older installations, and the danger of bursted tubes or explosions is very much greater unless good feed water is supplied. Therefore, from a safety standpoint clean feed water is becoming more and more essential, as more is expected of boilers and the design of the boiler proper has not changed commensurately.

Formerly evaporators were used only in chemical processes, or on shipboard where salt water compelled their use, whether economy was desired or not. Now an evaporator for make-up water for boiler feed is a standard piece of equipment in central stations except where corrosive water compels the use of jet condensers.

Some of the largest and best equipped water softening plants in this country have been installed in steel works, which shows that steel works engineers have found that pure feed water is as much of a necessity as the boiler itself, if modern conditions are to be met.

Pressures, Etc.

The steam turbine and the uniflow engine, particularly the former, offer a means of obtaining the economies that can be effected by the use of higher pressures and temperatures. The standard pressure for new steel works installations is now 250 pounds per square inch instead of 150 pounds. A pressure of 350 pounds is being accepted as standard by central station men and seriously considered by steel works engineers, while still higher pressures are discussed in this country and at least one plant is to be installed abroad for 500 pounds per square inch. The only questions that can be raised are, "Is the high pressure equipment too expensive," and "Can high pressures be used safely and without too much operating trouble?" To the steel works man, high pressures are common, as hydraulic pressures run into thousands of pounds. However, for steam to be used economically, it should be superheated and the higher the pressure the higher the initial temperature should be on account of the moisture formed as it is expanded in a turbine. It is the temperature which causes trouble, not the pressure, and most of the efforts of the designers and metallurgists are now expended to take care of weakening effect of temperature and the difference in expansion of different metals used. The solution of the problem seems to be to start with a high initial pressure and to superheat between stages similar to reheating in the receiver of a compound engine. This would require only a reasonable initial temperature even for 500 pounds

pressure and would eliminate most of the temperature troubles.

Piping and valves have proven to be the weakest link in most of the high pressure, high superheat stations. Boilers can be designed and operated just as safely on 350 pounds per square inch as on 150 pounds, except that at much above 350 pounds plates and rivets become unwieldy and the present standard designs of boilers would have to be modified. Turbines, except for packing troubles, have given little trouble traceable to high pressures and temperatures. Most of the trouble has occurred in the low pressure stages where pressures and temperatures are lower.

This is the age of steel in high pressure plants. Cast iron has been practically eliminated in boiler construction, in piping, valves and fittings and in at least part of turbine casings. The demand now is for high grade steel and workmanship in pipe and valves, which combined with welded joints would practically eliminate trouble from that source.

On account of the immense amount of auxiliary equipment and the large investment in buildings required for a modern power plant the additional cost of the high pressure, high superheat equipment over lower pressures is only a fraction of a per cent of the total cost. For instance, the difference in cost of a 1,300 hp boiler and feed pump from 200 to 250 pounds is only \$3,170 and there is no difference in the cost of piping and valves. From 250 to 350 pounds the difference including the proportionate cost of piping, valves and all accessories is about \$6,000. There is no difference in the cost of a 10,000 kw turbine from 200 to 250 pounds per square inch and only \$9,000 difference between 200 and 350 pounds per square inch. The increased cost of repairs is at least partially over-balanced by cheaper condensers and less condenser power on account of the decreased steam consumption at high pressures and by decreased demand on the boilers.

The interest on the increased investment figures out very high and, although actual operating costs are not as yet available, the fact that new plants are being installed and contemplated at 350 pounds per square inch shows that the savings are actual and not merely theoretical.

In the average steel works there are many existing prime movers in good condition, some of which are of recent date, but all operating on 150 pounds saturated steam. To obtain many of the benefits of high pressure, high superheat steam without interfering with present equipment and without excessive first cost, the following scheme was first contemplated for steel works and is actually being installed in the rubber industry. High pressure boilers with superheaters would be installed giving a pressure of up to 350 pounds per square inch and 150 to 200 degrees F. superheat, and the steam passed through turbines which would exhaust at 150 pounds and 75 degrees F. superheat, or lower as desired, into the existing steam mains supplying the engines, gas producers, etc., around the plant. The turbines would drive electric generators furnishing part of the electrical power for the plant. In this way 20 per cent more power would be obtained with 4 per cent additional coal consumption and in addition the economy of all existing units would be increased due to the superheat.

Superheaters.

The saving in steam consumption due to superheat varies from $\frac{1}{2}$ to 2 per cent for every 10 degrees F.

depending upon the design of the unit, being greatest for engines and small turbines and least for large turbines. Therefore, there is quite a saving possible in steelworks, where engines are widely used, the extent of which is limited by the ability of the engines to withstand the temperature. At 150 pounds pressure even large Corliss engines can operate without valve trouble at 70 degrees or more superheat, so in many cases superheaters from 70 to 100 degrees F. at the boilers are installed. Piston and poppet valve engines can withstand still higher temperatures, but the plant is usually limited by Corliss engines. The above conditions can also be well withstood by existing piping systems without radical changes. The saving is due, in engines, to decreased cylinder condensation and to greater specific volume of the superheated steam; and in turbines, mainly to eliminating blade friction of the moisture in the steam.

The necessity of superheat in order to obtain full advantage of higher pressures as well as the economy obtainable thereby with lower pressures and the use of superheated steam in coke and benzol plants for distillation, has resulted in superheaters being included in practically every new steel works boiler installation and in many older boilers being so equipped.

Engines and Turbines.

In order to obtain the economies of electric drive in the steel works and to meet the increasing electrical demand, larger turbines are being installed than formerly. While there are no exceedingly large units in steel plants, still there are many installations of from 10,000 to 20,000 kw, which sizes give good economy and compare quite favorably with central station practice. Units up to 45,000 kw in a single casing and up to 60,000 kw in a three casing machine have been installed in some of the largest stations, but turbines of this size are not required as yet for the steel industry on account of the immense amount of steam driven equipment in the plants and the desirability of having spares rather than tying all of the generating capacity up in one large unit.

While the turbo-blower, on account of the small turbine size and lower blower efficiency, cannot equal the economy of a gas engine or even the modern steam engine, its other advantages of close regulation, accurate air delivery, and small space and labor requirements have caused its adoption in many plants. Although some of the earliest units caused trouble and doubt, the later units appear to be quite satisfactory and turbo-blowers are a feature of some of the latest blast furnace installations.

The same conditions that have increased steam pressures for turbines and fostered the use of electric drive have caused pressures and temperatures for engines to approach those used in turbine practice. For instance the latest reversing engine installation is designed for 225 pounds per square inch pressure and 125 degrees F. superheat at the throttle. A noticeable feature of this engine is its simplicity and accessibility. While the twin-tandem engine is standard in the United States at present, it seems as though in order to fully utilize higher pressure and superheat that triple-tandem compound or multi-cylinder uniflow reversing engines may be the future competitors of electric drive. Triple-tandem engines have been built in Europe and have the advantage of lower inertia forces in addition to being better able, on account of smaller cylinders, to use higher pressures and temperatures. Reversing uniflow engines have been built for locomotives and for boats, but not as yet for rolling mills in this country, although the manufacturers appear to be willing.

For continuous running mills the uniflow engine is rapidly coming into prominence. The early installations have shown great reliability, while the economy of the uniflow over wide load ranges is almost an accepted fact. In this country last year there were three new installations for driving rolling mills, two of which were duplex engines; also several electric power installations. Two 40" x 48" duplex uniflow engines, which have just been completed for hot mill drives, will develop an average of 2,500 hp and a maximum of 5,000 hp each. Two more uniflow engines, one a 28" x 42" duplex and the other a 40" x 48" single engine are now being built. Governors have been developed with a very reliable and easily operated speed-changing device so that all conditions of service can be met. In view of the numerous installations of electric mill drives, the status of the steam engine for roll drives appears to be dependent upon how much use is made of the economies to be effected by high steam pressures and temperatures, either by the use of pressure reducing turbines, or by direct application to the engine.

Condensers.

For years the barometric condenser was the standard for steel works on account of freedom from corrosion and repairs, and ability to use dirty water. This type of condenser, also, if properly designed can hold a fair vacuum even if the air pump is out of operation.

The advent of the turbine, which utilized a much higher vacuum than the steam engine, necessitated an abnormally large exhaust pipe to keep friction losses down to a minimum. Therefore, the low-level jet and surface condenser, which could be attached directly to the turbine exhaust, were used for large installations as is the practice in central stations. While corrosive or exceedingly dirty water compels the use of the jet condenser, as all parts can be made of cast iron and cleaning is reduced to a minimum, the surface condenser offers many economies. A surface condenser will cost from 50 per cent to 75 per cent more than a low-level jet type, but it saves the condensate and requires less power to operate.

Even though the condenser in question condenses only a fraction of the total steam of the plant it will save the difference in cost in a short time from the feed water saving alone, as is shown by the following calculation, by eliminating the necessity of treating that amount of water and, in case untreated water is used in the boiler, the saving will be at least double that shown.

Size of turbine.....	10,000 K. W.
Cost of surface condenser.....	\$75,000
Cost of low-level jet condenser.....	45,000
Difference.....	\$30,000
Cost of feed water from water softening plant	\$0.07 per 1,000 gallons
Condensate per 10,000 kw x 13 lbs. per kwh	
hour equals	$\frac{15,600}{8\frac{1}{2}} = 15,600$ gals. per hr.
Value of feed water saved per hour	$\frac{15,600}{1,000} \times \$0.07 = \$1.09$
Value of feed water saved per year of 310 days = $310 \times 24 \times \$1.09$	= \$8,120
Interest on investment from feed water saving alone	$\frac{8,120}{30,000} = 27\%$
or the difference paid for in about three years.	

The water softening plant can be made smaller on account of the surface condenser resulting in a saving in investment of approximately \$16,000. In addition there is a saving in power of \$12,000 per year if motor driven

auxiliaries supplied from the turbine are used. This is due to less air-pump power on account of not having to remove air from the circulating water and to lower circulating water head. Thus there is \$8,120 plus \$12,000 or \$20,120 saving per year on an investment of \$30,000 less \$16,000 or \$14,000.

The surface condenser has a further advantage of furnishing an absolute check on turbine performance if the condensate is metered. While the difference in first cost as shown cuts little figure on account of the savings effected, more labor will be required for cleaning and packing and there will be some drop in vacuum between cleanings if the water is very dirty. However, unless the water is very slimy or corrosive, a surface condenser pays, and in spite of the lead which the barometric type had, surface condensers are being widely used in the steel mills and furnace plants.

Gas Engines.

The modern blast furnace gas engine shows much greater reliability and a somewhat higher thermal efficiency than formerly, but the steam turbine plant when high pressures and superheat are used and all auxiliaries such as gas washers, are taken into consideration, runs a pretty close second in regard to economy and can be installed at a much lower figure. However, all of the possibilities of the gas engine have not been taken care of, although some work has been done along this line in this country and considerable in Europe. By utilizing the heat of the exhaust and the heat of the jacket water the thermal efficiency of the entire system can be made at least double that of the engine alone. In one plant in the United States the exhaust is to be used to run a high pressure boiler; in Germany low pressure boilers and low pressure turbines are used to some extent. In another plant the equivalent of 100 boiler hp per 3,000 kw engine is obtained by a very simple and inexpensive air heater which is used to heat the buildings and which increases the back pressure on the engine less than two inches of water. However, this last is only used in winter and could be made more effective as up to 300 boiler hp is readily available from the exhaust.

The use of jacket water as boiler feed water is another method of improving the economy of the system by saving the jacket water loss, and enabling the gas engine to compete with steam driven equipment in spite of high cost. This is already being done and other installations contemplated, in connection with economizers, utilizing the heat in the exhaust gas. This is an almost ideal source of waste heat as the jacket water is not contaminated and the exhaust gases are quite clean. The only consideration is to not create too high a back pressure on the engine.

Air Compressors and Hydraulic Pumps.

Systems of even somewhat minor importance in comparison to the main power supply have received considerable attention in many plants. For instance the air compressing and distributing systems have been carefully studied, resulting in the installation of large central compressors in the power house and the elimination of small isolated compressors. This results in better attention with less labor, as the compressors are under attendance of the power house employees, greater reliability, and much better economy. The compressors themselves are not only more efficient, due to larger size and condensing operation, but steam lines to the isolated compressors with their accompanying radiation losses are replaced by

air lines with no heat loss. In connection with the central compressors, after-coolers are installed to prevent freezing of condensation in the exposed air lines. A few noteworthy installations of the air-cooled type have been made and are operating successfully.

The same tendency to centralize is evident in the hydraulic systems. In addition to centralization of pumps the economy is carried also throughout the entire system by properly proportioning cylinders to the load, better attention to operating valves and packing, but particularly by the use of clean water. Clean water reduces valve trouble, both in the pumps and operating valves, plunger scoring, and greatly decreases the quantity of hydraulic water used. While many plants use water from the water softening system for hydraulic make-up, in some cases separate filters have been installed and found to result in a saving of labor as well as greater reliability.

THE HARDNESS OF ELECTROLYTIC IRON

In the year 1906, Dr. H. C. Boynton, of Harvard College, communicated to the Iron and Steel Institute an account of experiments on the "Hardness of Constituents of Iron and Steel," interesting also on account of the method by which he determined the hardness. He made use of the microscelerometer of Professor T. A. Jaggard, also of Harvard, in which a fine diamond point is rotated at very high speed and the depth of the hole drilled is measured. Experimenting on pure electrolytic iron, ferrite, Boynton found that the etching of the original or remelted specimens made no difference in the hardness, the relative hardness figures being 505 and 460, but that quenching from high temperatures doubled the hardness, quenching at 850 degrees C. (B iron) raising the hardness to 998, and quenching from 1,300 degrees C. to 982. In *Stahl und Eisen* of May 12 last, Drs. V. Bauer and W. Schneider, of the Technical High School at Breslau, describe experiments, made by a different method, which do not show this marked influence of quenching. They took cubes of electrolytic iron, of 10 mm edge, normalized by heating to 950 degrees C. for half an hour, and quenching them from eight different temperatures ranging from 650 degrees up to 1,250 degrees C. Determining the hardness by the Brinell method, they found no influence of the quenching temperature at all, all the hardness values lying between 57 and 59.3. They do not question the accuracy of Boynton's results, however, but point out that the Brinell hardness is not the hardness of Boynton. The former marks the resistance which the material opposes to penetration of a harder substance into it, while the Jaggard method measures the resistance opposed by the smallest particles to the rotating diamond. Brinell hardness and capability of being machined do not go together; austenitic manganese steels are soft and yet difficult to machine, while the Boynton hardness would indicate the relative ease with which the material can be machined. Bauer and Schneider also made tensile strength tests, on strips of 16 mm by 2.5 mm cross-section, 120 mm long, without finding any noteworthy differences caused by quenching, and other tests with turned rods, reheated in a vacuum, were equally concordant. But Bauer and Schneider did not extend their examination to various steels at Boynton had done.

WITH THE EQUIPMENT MANUFACTURERS

There are probably more difficult engineering problems met in the design and building of electrically driven cranes than in any other standard line of machinery. Not only are the cranes used for radically different kinds of work, but the dimensions, the speeds, and numerous other factors are constantly being altered.

Among some of the more peculiar demands are those for cranes to travel around curves, others to run on a straight track part of the time and the remainder on a curved track, and for others to travel in complete circles.

A patent was recently secured on a method of driving a crane on a circular track by R. W. Valls, vice president and general manager of The Champion Engineering Company, Kenton, Ohio, builders of Champion cranes. This is said to be quite an improvement on former devices, and the illustration shows quite clearly how the object is accomplished.

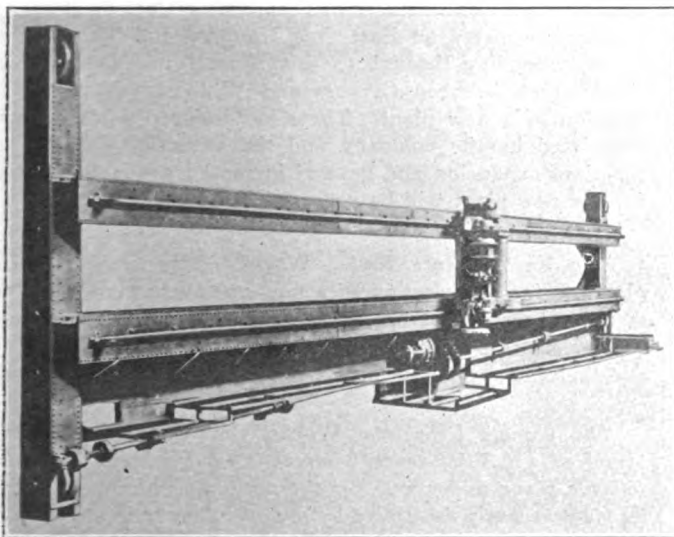


Fig. 1.

On cranes of this kind it has been customary to make the track wheels for the outer radius considerably larger than those for the inner track, and to use different sizes in gears and pinions. This meant complication in design, having various sizes of gears and pinions, and keeping many more "spares" on hand, the parts not being interchangeable.

With the construction shown, all track wheels, gears and pinions are of a size, excepting one gear and pinion at the center of bridge. This allows the use of one size gear case. It simplifies the construction greatly, reduces upkeep cost and the repair time.

The crane shown was built for the round house of the Pennsylvania Lines, Columbus, Ohio, and notwithstanding the span is 75 feet, it is said the loss in traveling the complete circle is but one-eighth inch. It has been the cause of many most favorable comments.

All cranes have a tendency to get out of square on the runways, this being emphasized on cranes on curved tracks. By a very simple device, covered by the same patent, the crane may be squared up again in a few moments. This squaring up device is applicable as well to cranes operating

on straight tracks as the differential gear provided forms the correcting means for accomplishing that purpose.

GAS MASK FOR CARBON MONOXIDE PERFECTED.

The first public demonstration of the gas mask for protection against carbon monoxide, manufactured by the Mine Safety Appliances Company, Pittsburgh, Pa., and in which is utilized the special chemical mixture called Hopcalite, developed by the United States Bureau of Mines and Chemical Warfare Service, United States Army, was given the afternoon of May 26 in the special smoke room of the United States Bureau of Mines, Pittsburgh, Pa. The United States Bureau of Mines in its research of various types of gas masks, including the carbon monoxide mask, has a large smoke room especially adapted for testing purposes, and the courtesy of the use of this smoke room was extended for this demonstration. In addition the first public demonstration was also given of the United States Bureau of Mines Gas Mask for city firemen, also containing Hopcalite, for carbon monoxide protection.

In this test two men entered the smoke room which contained 1 per cent of carbon monoxide gas in the air. One of the men carried a canary bird into the room to indicate to the observers the poisonous nature of the atmosphere. The canary bird collapsed in 45 seconds, and was immediately removed to fresh air, where it was revived with oxygen.

Tests were also frequently made with the M-8-A Carbon Monoxide Detector to show the observers the strength of the gas. The wearers of the mask remained in the atmosphere for 30 minutes, doing vigorous work part of the time, and experienced no ill effects whatever from the poisonous carbon monoxide gas. The gas masks gave perfect protection throughout the entire period of the test.

The carbon monoxide gas mask is of special interest to iron and steel industries, fire departments, industries using gas producers, illuminating gas plants, coal and metal mines and to all other persons who are apt to encounter carbon monoxide gas in their work.

Carbon monoxide occurs frequently in dangerous quantities around blast furnaces, gas producers, etc., and is a constant hazard because of its poisonous nature. A simple protective device, light in weight, devoid of all complicated mechanisms has long been needed for the protection of men engaged in such work.

While the gas mask used will give protection in higher percentages of carbon monoxide, 1 per cent of carbon monoxide in the air will kill a man in a few minutes' time. The percentage found in working places where there is ventilation usually amounts to considerably less than 1 per cent.

One-tenth of 1 per cent of carbon monoxide, however, will seriously effect a man who is working and therefore breathing hard in about one-half hours' time, while two-tenths will effect him seriously in about 10 minutes' time.

The carbon monoxide gas mask is therefore of great importance to the country's industries and it is important to note that a splendid accomplishment of the United States Bureau of Mines and Chemical Warfare Service in their work on poisonous gases during the war has been adapted to a most important industrial use.

NEWS OF THE PLANTS

The Richard French Iron Works, Worcester, Mass., has acquired property on Howe avenue, Millbury, for the erection of a new plant for the manufacture of general iron products. The proposed works will replace the company's plant at Worcester, recently purchased by the Arcade Malleable Iron Company, a branch of the Baldwin Chain & Manufacturing Co. Plans for a number of buildings are nearing completion, with main structure to be 50 x 120 feet, and a number of smaller buildings adjoining. Construction will be inaugurated at an early date, and the plant ready for service in the early fall.

The Whitaker-Glessner Company, Portsmouth, Ohio, has placed its new continuous sheet mill for rolling bars in operation, bringing considerably increased production in this department of the works. The plant consists of six stands of 18-inch roughing and finishing rolls, supplemented by two edging mills. The rated output approximates 40,000 tons of 10-inch sheet bars per month. A new power plant has also been installed, with extensive capacity to provide for future contemplated extensions.

The Wheeling Steel Company, Wheeling, W. Va., has preliminary plans under way for the erection of a number of additions to its La Belle Iron Works, Steubenville, Ohio, providing for considerable increased capacity. It is proposed to make this the leading plant unit of the recent merger of steel interests under the Wheeling Steel Company name. A number of new buildings will be erected and improvements made in present structures. The work, including machinery, is estimated to cost in excess of \$1,500,000.

The American Wire Fabrics Company, 208 South La Salle street, Chicago, Ill., has completed plans for the erection of a new galvanizing plant at its works at Blue Island, Ill., to be located on Western avenue. The structure will be one story, 48 x 145 feet, and will be supplemented by another structure to be used for general storage and works service. The buildings will cost about \$100,000.

Luria Brothers & Co., Lebanon, Pa., iron and steel products, has perfected plans for the establishment of a new yard in the North Side District, Pittsburgh, Pa. It will be fully equipped to handle small and large material, with installation provided for covering locomotive cranes, shears, and handling equipment. It is proposed to place the yard in service at an early date.

The Chester Iron & Foundry Co., 7800 Vulcan street, St. Louis, Mo., has completed plans for the erection of two additions to its plant for increased capacity. The main structure will be 45 x 115 feet, and will be used for general operating service, while the other building will be 20 x 35 feet. A. J. Schaelich is president of the company.

The Cleveland Structural Steel Company, 6600 Park avenue, Cleveland, Ohio, is completing plans for the erection of a one-story addition to its plant on Highland avenue for increased production. It will be 55 x 112 feet, and is estimated to cost about \$25,000.

The Birmingham Steel Company, Birmingham, Ala., is being re-organized under an agreement with creditors, who recently filed a petition in bankruptcy against the company. The plant will be operated in the future as an independent steel fabricating organization, and present affiliation with the Mobile Shipbuilding Company will be discontinued. The corporation is said to be solvent, and extensive production plans are under way in connection with the re-organized company.

The Empire Rolling Mill Company, Bessemer avenue and Pennsylvania Railroad, Cleveland, Ohio, has commenced the erection of a new steel galvanizing plant, to be one story, 50 x 130 feet. A warehouse building will also be constructed. The entire work is estimated to cost close to \$55,000. C. G. Borkwell is president.

The A. C. Chesley Company, Inc., 277 Rider avenue, New York, N. Y., manufacturer of fireproofing steel products, has acquired property on East One Hundred and Thirty-second street, extending through to East One Hundred and Thirty-third street, between Cypress and Willow avenues, for the erection of a new plant. The site adjoins a works recently completed by the company and the extension will be used for plant expansion and general increased production. Plans for the new plant will be prepared at an early date.

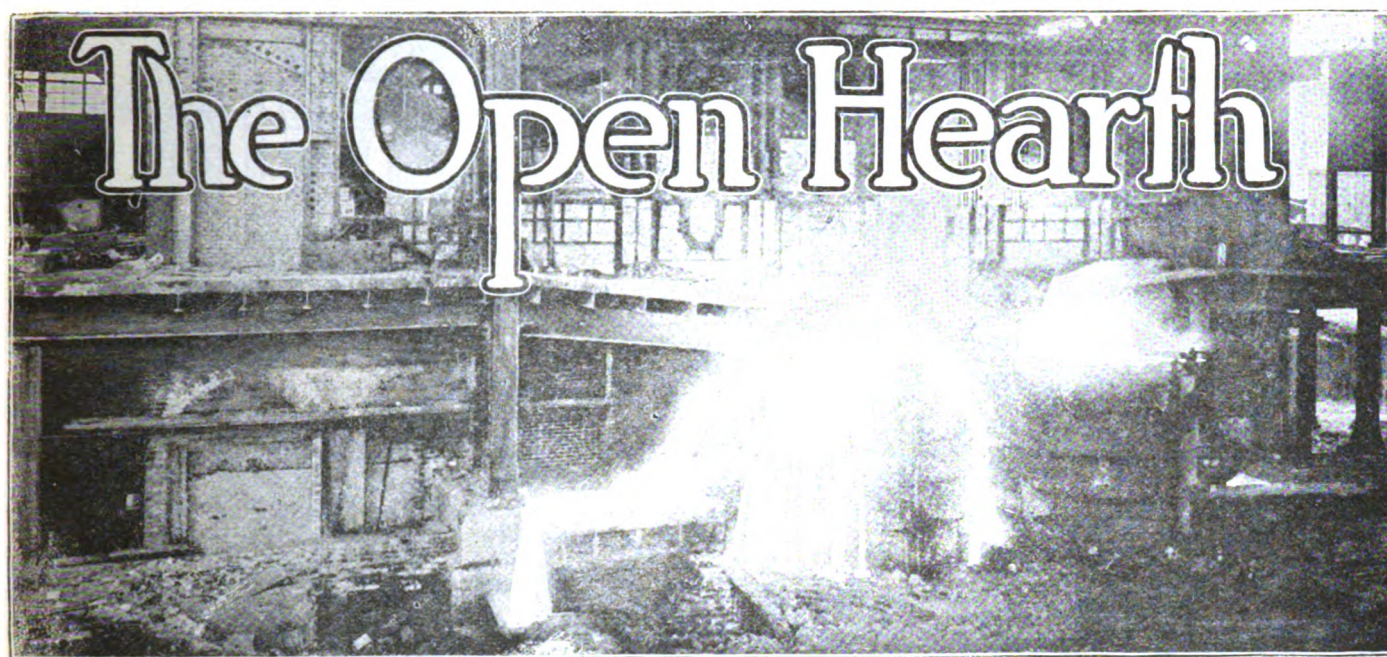
The Terre Haute Boiler Works, Terre Haute, Ind., is planning for the erection of a new one-story plate mill, estimated to cost about \$75,000 with machinery. The structure will be used for fabricating work in connection with boiler and tank construction.

The Samuel Uris Iron Works, Gerard avenue and One Hundred and Fifty-seventh street, New York, N. Y., is said to have plans under way for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at close to \$30,000.

The Virginia Bridge & Iron Company, Roanoke, Va., with plant at Memphis, Tenn., has acquired local property, consisting of the former works of the Anchor Saw Mills on the Wolfe River, comprising about 10 acres of land. The company will commence the immediate remodeling of the plant and install equipment for the manufacture of all-steel barges. The company will use its fabricating works at North Memphis in connection with the barge plant. Orders have been taken for the construction of a number of barges at the earliest possible date.

The Paragon Foundries Company, Oregon, Ill., manufacturer of iron plates, etc., is having plans prepared for the erection of an addition to its plant for increased production. It will be one-story brick, 100 x 200 feet, and is estimated to cost about \$50,000. Bids will be taken at an early date. James Reed is president of the company.

The New England Steel Casting Company, Shaker Road, East Longmeadow, Mass., is planning for the rebuilding of its local plant, recently destroyed by fire, with loss estimated at close to \$100,000, including equipment.



Floyd Rose, secretary of the Heppenstall Forge & Knife Co., Pittsburgh, was recently made general manager of sales of the Heppenstall Forge & Knife Co., and also of the Heppenstall Forge Company.

✓ ✓

Wm. B. Schiller, president of the National Tube Company, sailed July 1 for Europe.

✓ ✓

L. A. Holmes, engineer, McClintic-Marshall Company, Pottstown, Pa., has been transferred to the Boston office of that company.

✓ ✓

H. W. Bishop, Jr., recently resigned from the LaBelle Iron Works, Steubenville, Ohio. Mr. Bishop was connected with the general sales office of this company for 10 years, and since the consolidation of LaBelle Iron Works, the Whitaker-Glessner Company and the Wheeling Steel & Iron Co., identified with the Pittsburgh sales office of the Wheeling Products Company. It is understood that he will make a connection with an Eastern steel company.

✓ ✓

Isaac Harter, assistant to the president of the Babcock & Wilcox Co., 85 Liberty street, New York, builder of boilers, stokers, etc., has been appointed general superintendent of the company, succeeding the late James P. Sneddon.

✓ ✓

S. V. McLeod was recently appointed purchasing agent of the Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ont., succeeding L. L. Jacobs, resigned. Mr. McLeod's headquarters are in Sault Ste. Marie.

✓ ✓

Robert Palm, who was formerly connected with the Chrome Steel Works, Chrome, N. J., as chief engineer, is now with the export department of the Texas Company.

✓ ✓

Dexter S. Kimball, whose nomination for the presidency of the American Society for Mechanical Engineers recently was announced, in addition to being dean of the College of Engineering, Cornell University, is one of the country's best known engineers and has been active in promoting a closer union of engineering organizations. With Herbert C. Hoover, now Secretary of Commerce, he aided in organizing the Federated American Engineering Societies, and is one

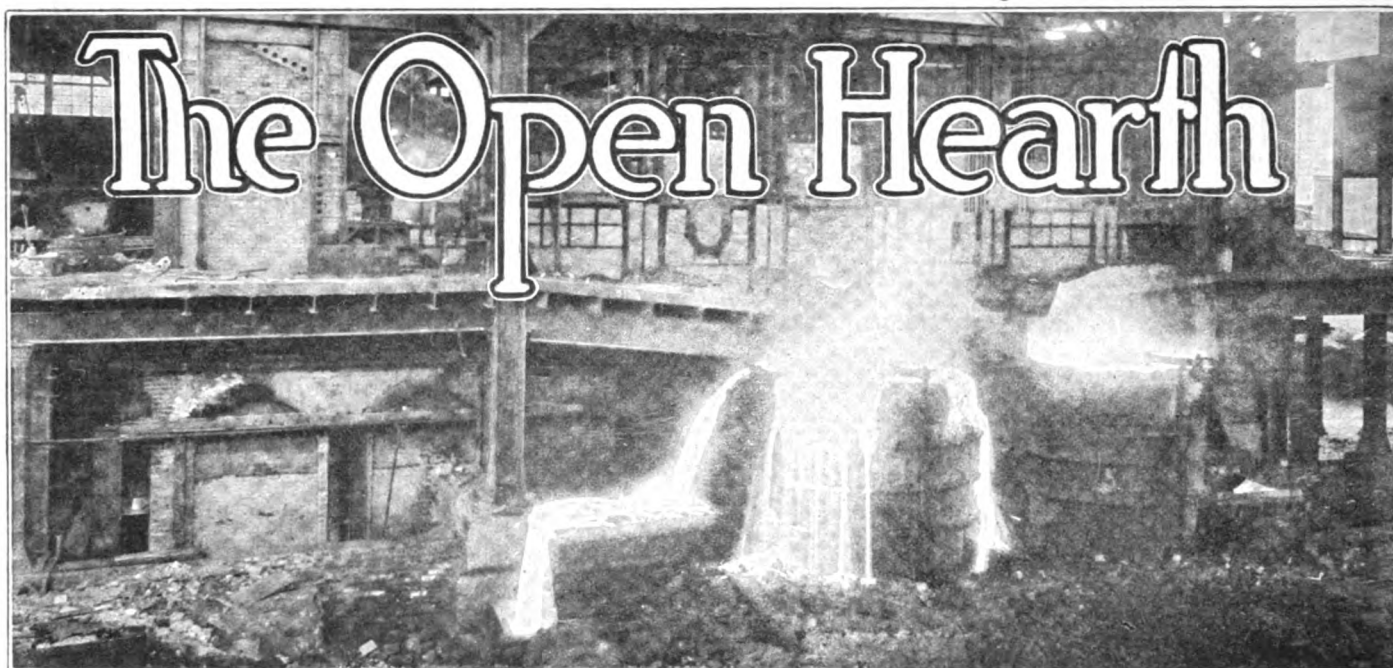
of the vice presidents of the American Engineering Council, the executive branch of that federation.

✓ ✓

Walter S. Tower, who has been trade adviser of the Consolidated Steel Corporation, New York, took up, on Monday, July 11, work with the Department of Commerce, to which he has been assigned by Secretary Hoover. While Mr. Tower's position has not been clearly defined, it is stated, contrary to press reports, that he will not be the chief of an industrial division on iron and steel, at least not in the immediate future. His first task is expected to be in connection with a request made by the United States Shipping Board to the Department of Commerce, to assist the former in the organization of work looking to the gathering and analysis of shipping statistics. Mr. Tower, who is 40 years of age, was born in West Bridgewater, Mass., where he obtained his public school education. He is a graduate of Harvard, getting the degrees of A.B. and A.M. in 1903 and 1904, respectively, and also graduated from the University of Pennsylvania with the degree of Ph.D. in 1906. For a series of years, and up to 1917, he was engaged in teaching and traveling. While traveling he studied trade conditions, chiefly in North and South America. After that, he became connected with the Shipping Board. He has written several articles concerning Latin-American trade conditions. During the war he was associated with the Division of Planning and Statistics of the Shipping Board. Upon the resignation, in March, 1919, of E. F. Gray, as director of that division, he was succeeded by Mr. Tower, who remained in that position until June, 1919, when he went with the Consolidated Steel Company.

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Carl A. Wendell, of New York, who was in charge of coal washing investigations for the United States Steel Corporation at Joliet, Ill., from 1908 to 1913, has been made consulting engineer of the Federal Bureau of Mines in matters pertaining to coal washing and preparation. Since leaving the corporation in 1913, Mr. Wendell has been acting in a general consulting capacity. Beginning July 1, Mr. Wendell will visit several eastern stations of the bureau and will advise frequently with officials of the bureau. At the University of Illinois, Urbana, Ill., research work is being carried on to assist the development of successful methods for cleaning



high sulphur coals, to render them suitable for coke and gas making, and in this work Mr. Wendell will assist.

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William S. Fisher, St. John, N. B., who was recently elected president of the Canadian Manufacturers' Association, is president of the Enterprise Foundry Company, Sackville, and vice president of Emerson & Fisher, Ltd., St. John. He was president of the St. John Hardware Association in 1907, and president of the St. John Board of Trade in 1896 and 1897, and president of the maritime branch of the Canadian Manufacturers' Association from 1914 to 1918. In 1918 he was called upon by the war purchasing commission to take charge of the outfitting of the first construction battalion in France, and in April, 1919, the Canadian government appointed him commissioner in charge of the Dominion rifle plant at Quebec.

✓ ✓

Donald P. Hess was recently appointed general manager of the Columbus, O., plant of the Timken Roller Bearing Company, Canton, Ohio, succeeding C. N. Replogle, resigned. Mr. Hess has been connected with the Timken Roller Bearing Company at its Canton plant for three years.

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Stuart B. Marshall, consulting engineer and metallurgist of Washington, was recently elected president of the Virginia Military Institute alumni in Washington. Mr. Marshall was formerly general manager of the American Manganese Manufacturing Company, Dunbar, Pa., and general superintendent of the Aluminum Company of America business in North Carolina.

✓ ✓

A. Bowman, formerly in charge of the Lebanon, Pa., yard of Luria Bros. & Co., Lebanon, scrap dealers, is to take charge of a new yard soon to be opened by the company at North Side, Pittsburgh.

✓ ✓

N. Julien Thompson has left the employ of the State of Connecticut Industrial Waste Commission, and will be retained by the Standard Rolling Mills Company of Springdale, Conn., as engineer, in charge of development work on a by-product lithopone plant.

H. H. Barker, formerly chief chemist and plant manager of the Ore Products Corporation, Denver, Col., is now chief chemist of Corning & Co., Albany, N. Y.

✓ ✓

The Society for the Promotion of Engineering Education has elected the following officers for the ensuing year: President, Charles F. Scott, Yale University; vice presidents, H. J. Hughes, Harvard University, and E. J. McCaustland, University of Missouri; secretary, F. L. Bishop, University of Pittsburgh; treasurer, W. O. Wiley, New York City. The following are members of the Council: P. H. Daggett, University of North Carolina; J. H. Dunlap, University of Iowa; M. L. Enger, University of Illinois; J. C. L. Fish, Leland Stanford University; F. E. Gieseke, University of Texas; Morris Knowles, Pittsburgh, Pa., and O. M. Leland, University of Minnesota.

✓ ✓

W. W. Odell, fuels engineer of the Bureau of Mines, is now in North Dakota, where he will coöperate with Prof. Babcock of the University of North Dakota on an extended series of tests of lignite carbonization. The experimental work will be done in the small lignite coking plant of the University as a portion of the coöperative work of the Bureau of Mines and the University.

✓ ✓

Peter Eyermann, who was connected with steel work in Austria during the war and since the armistice has been manager of the Bohemian State Steel Works, was recently appointed manager of the Austrian arsenal at Vienna. Mr. Eyermann was engaged in steel work engineering in the United States about 20 years ago, particularly in connection with the introduction of the blast furnace gas engine. Later he had offices at DuBois, Pa. On going to Europe some years ago, he was connected for a time with the steel works at Witkowitz, Austria.

✓ ✓

F. E. Norris, formerly general superintendent of the Sharon and Farrell works of the Carnegie Steel Company, is expected to return from France about August 1st, where he has resided for two years. Mr. Norris has been supervising construction of an open-hearth plant and rolling mills for the M. Berliot Automobile Company, near Lyons, France. It is understood the company has abandoned plans for additional work after about half completing its plant.

Some Pointers on By-Product Coke Oven Operations

THE MANUFACTURE OF ALCOHOL FROM COKE OVEN GAS.

By C. F. Tidman.

PART II.

To give surface alone, special packing material was used at Skinningrove in plant experimental towers, but although a large surface was provided, allowing three minutes' contact, 80 to 90 per cent absorption of the ethylene was not obtained.

Keeping in mind these facts, a series of experiments was carried out in a flask of 1950 cc capacity filled with dry desulphurized coke-oven gas. The flask was heated in a water bath until the temperature of the gas was about 80 degrees C., hot acid (300 cc) was added and the flask covered with a non-conducting material and vigorously agitated, to afford adequate surface contact, for periods varying from ½ to 3 minutes. Further experiments were carried out using 5 per cent of silica with the 95.4 per cent sulphuric acid. The results obtained are shown in Fig. 2, from which it is seen that the addition of silica increases the absorption by approximately 5 per cent. The function of the silica is not quite clear, but it appears to have a catalytic action and not merely a surface effect, since during the first few experiments on the small laboratory towers the absorption was particularly good, while a much later experiment, using the same towers, showed a falling off in percentage absorption, conditions remaining exactly the same except that the silica packing was coated with a slime of lead sulphate. In the experiments just described the addition of silica greatly increased the amount of froth formed on the surface of the acid, thus giving much better contact between gas and acid.

From the figures quoted it will be seen that for three minutes' contact by either method—towers or direct agitation in flask—the percentage absorption is 90 per cent, so that whichever method of scrubbing is finally adopted—i. e., towers or mechanical washer—it should be possible to remove 70 to 80 per cent of the ethylene by allowing 2½ to 3 minutes' contact.

Spraying the acid into the gas has also been tried, but difficulties occurred in maintaining the required temperature and also in blocking of the sprays. It was decided that this type of scrubber was not suitable. However, certain forms of mechanical washers give practically the spray effect without the disadvantages of blocking of small jets as used in sprays.

The next point to be determined is how nearly sulphuric acid can be saturated with ethylene before it will cease to act as an efficient absorber. Mr. Bury stated that 18 per cent of the acid radicle is available for ethylene absorption, i. e., 95 per cent sulphuric acid (R. O. V.) would continue to absorb ethylene until reduced to 77 per cent H_2SO_4 . We have since found, however, that acid already saturated 18 per cent would still continue to absorb ethylene in a mechanical agitator, 30 per cent of the ethylene present being absorbed in 2½ minutes.

A mechanical washer would have the advantage over a tower scrubber system in that the size of the plant would be much reduced, and the power required to drive such washers is not great, considering the power required for pumping and the inconvenience of periodically cleaning a tower

scrubber. The absorption product contains free alcohol in addition to sulphuric acid, ethyl hydrogen sulphate, and diethyl sulphate. This was apparent from the results of a trial run on the experimental plant. From analyses of the gases from each scrubber it was seen that No. 1 scrubber gave a shortage when distilled for alcohol, but scrubbers 3 and 4 each yielded more alcohol than was indicated by the gas test. In a number of tests the free alcohol has been as high as 50 per cent of the total yield. It was therefore, decided to recover the alcohol by distillation under reduced pressure, first allowing distillation to proceed without steam, and admitting steam when the temperature of distillation increased so that the speed of distillation was maintained. The following figures indicate the procedure. The acid was first diluted to 64 per cent H_2SO_4 by the addition of water. Under a vacuum of 26½ inches, distillation commenced at 94 degrees C., the highest temperature recorded being 146 degrees. The alcohol distilled over satisfactorily, and no frothing took place. The finished acid, which was free from alcohol, free or combined, showed 80 per cent H_2SO_4 .

The method suggested earlier for recovery of the alcohol was to use a counter-current flow of acid and superheated steam. Over short periods, this method was satisfactory, but after a time large amounts of froth were produced, which passed into the condensing system.

The bulk of the alcohol obtained from this process is in the form of a 15 per cent distillate, any weaker distillate obtained being used for diluting the acid to the strength required for distillation in vacuo. The production of strong alcohol from this weak distillate is hardly within the scope of this paper, since the distillate is of a very similar strength to that obtained by fermentation. The alcohol itself, however, is very interesting in view of the impurities present. These are not important when the alcohol is to be used as fuel, since the alcohol burns completely—indeed, it has been considered possible that the revenue authorities may even accept the spirit as sufficiently denatured to pass into use without the addition of other substances; certainly the crude spirit is much less potable than methylated spirit. The alcohol, however, possesses an objectionable odor, which persists in other products made from it. For example, chloroform made from by-product alcohol was reported to satisfy B. P. requirements only after treatment with hot concentrated sulphuric acid to destroy the odorous substances, the washing process reducing the bulk 10 per cent. In preparing strong alcohol from the weak distillate it had been noted that the weak distillate was often cloudy, but became clear on heating, showing that the substance present was more soluble in hot than in cold alcohol. Repeated distillations from the 80 per cent alcohol left a residue which on cooling deposited a white, crystalline solid, which was found to be diethylene disulphide (mp 111 degrees C., uncorr.). In addition to this impurity a yellow oil containing about 15 per cent of sulphur was found on the surface of the weak distillate. Both forms of impurity were present in largest amount in the first scrubber. Since only a small quantity of the oil is available and it has a wide range of boiling point, it has not been possible to fix definitely the exact substance present. A further difficulty in that diethylene disulphide is very soluble in this oil and consequently it is difficult to obtain the oil free from this substance.

TRADE NOTES

Removal of its Pittsburgh offices from 940 Oliver Building to 647-648 Oliver Building, has been announced by the American Manganese Manufacturing Company, Philadelphia.

Announcement has been made of the appointment of F. E. L. Whitesell as New England representative of the Railway & Industrial Engineering Company, Greensburg, Pa., with offices at 136 Federal street, Boston.

The Pawling & Harnischfeger Company, Milwaukee, has moved its San Francisco offices from the Monadnock Building to 32 Beale street, where a show room and stock are being maintained.

The Link-Belt Company, Chicago, has acquired all of the capital stock of the H. W. Caldwell & Son Co., and Frank C. Caldwell has been elected a director of the Link-Belt Company. The Link-Belt Company has thus added two new lines, helicoid conveyors and power transmission machinery, to its present line of manufacture. The H. W. Caldwell & Son Co.'s plant will continue to operate under separate corporate existence and under its present name.

The Combustion Engineering Corporation, New York City, announces that the sales organization in Philadelphia has been increased and a new service department inaugurated, which has necessitated getting new office space. Its new location is on the tenth floor of the Finance Building. The territory is under the management of W. C. Stripe.

The Electric Furnace Construction Company, Philadelphia, Pa., announces that the Companhia Electro Metallurgia Brasileira and the Batcheller-McConnel Company, New York City, have recently acquired from Frank Hodson, president of the company, and his Swedish associates the exclusive rights and licenses for Brazil for the Gronwall type "Electrometall" electric shaft smelting furnace. Two large furnaces, each of 3,000-kw capacity, are at present being installed by the Brazilian company.

The Metal & Thermit Corporation, New York City, has recently transferred William Aldrich from the Southern territory to the Western territory. He will travel extensively through California, Oregon, Washington, Idaho, Nevada, Utah and Arizona, and will make his headquarters at the new South San Francisco office. William H. Moore, who until recently was assigned to the Chicago territory, now has charge of the Southern territory. This company also announces that in order to handle more satisfactorily its detinning business in the West it has constructed and will shortly place in operation in South San Francisco, Cal., a large new plant for the production of detinned billets, in addition

to the detinning plants already operated at Chrome, N. J., and East Chicago, Ind. This new plant has been equipped with a large welding shop containing equipment and facilities for undertaking repairing by the Thermit process.

The Terminal Engineering Co., New York City, has added to its staff J. F. McGonigal, formerly of the Foamite Co., and J. H. Potter, a graduate of New York University. M. E. Lyle, for many years with the Columbia Graphophone Company, has been elected a vice president and is directly responsible for new business, and M. E. Peck has been elected secretary and assistant treasurer.

The Allied Machinery Company of America, 51 Chambers street, New York City, have been appointed foreign representatives in all countries except the United States and Canada for the Universal Crane Company.

H. J. Freyn, president, Freyn, Brassert & Co., Chicago, Ill., sailed for Europe on an extended business trip through England, Belgium, Holland, France and other countries. Mr. Freyn is expected to return in October.

TRADE PUBLICATIONS

The fourth edition of the A. B. C. of Iron and Steel has been issued by the Penton Publishing Company. This book describes accurately and completely, but in a simple, interesting, and non-technical way, every step in the manufacture of iron and steel from the ore to the finished product. It is not intended for the technical specialist, but for the busy, practical man who wants to have a broad, general knowledge of the whole iron and steel industry. From the top of the first page to the bottom of the last, there isn't a sentence that needs explanation, and, to make everything doubly clear and understandable, over two hundred photographs of iron and steel mill operations and equipment have been included.

The Link-Belt Company of Chicago, Indianapolis, and Philadelphia have just issued a new Steel Chain Data Book No. 475. In this book is presented completely the heavier rugged steel chains used for power transmission, and also including elevating and conveying chains.

The Chicago Pneumatic Tool Company, New York City, has issued Bulletin 648, which describes little giant geared air hoists, motors and winches. This bulletin shows application views of this hoist in various industries and for innumerable operations, such as handling steel plates in storage yards, serving sheet steel to cutting machine at large boiler shops, etc. Copies will be sent to those interested, upon request.

The Draper Manufacturing Company, Cleveland, Ohio, has issued a very attractive catalog, No. 7, entitled "Steel Barrels for All Purposes." The first section

illustrates and describes the various types of steel barrels and gives their capacity, dimensions, cubic space, weight and average number to car load. The Interstate Commerce Commission tests to which these barrels were subjected are explained. Pages 103 to 160 contain useful tables not ordinarily found in a catalog of this type. This feature makes the booklet of unique value.

The Pawling & Harnischfeger Company, Milwaukee, Wis., has issued two new leaflets, on shovel attachment for P. & H. types 205 and 206 excavator-cranes.

Carrier Air Conditions Company of America, Buffalo, N. Y., has issued Catalog 480, on "Carrier Air Washers and Humidifiers," which is well illustrated.

The Sullivan Machinery Co., Chicago, Ill., has just issued Bulletin 78-A, which describes and illustrates dry vacuum pumps, single cylinder, steam and belt driven. These pumps are equipped with improved water type plate valves for both intake and discharge openings. The Sullivan turbinair hoist is another new product, which is described in Bulletin 76. These hoists are used in mining of coal and metal and in many phases of industrial work.

The Wheeler Condenser & Engineering Co., Carteret, N. J., announces the publication for the 1921 edition of its "Steam Tables for Condenser Work." This is the sixth edition. The tables are in book form, pocket size. The properties of saturated steam are tabulated from 29.8 inches vacuum to atmospheric pressure in increments of tenths of an inch referred to a 30-inch barometer. The values were especially calculated for this book by Prof. Marks. As it is customary in vacuum work to read vacuum in inches of mercury, this is superior to the old method of giving absolute pressures in pounds per square inch. Above atmospheric pressure the increments are in pounds gauge. The book explains how measurements are made by means of the mercury column and barometer, and gives constants and tables for making corrections. Corrections for the thermal expansion of mercury, for the relative expansion of mercury and brass scale, and other corrections are included.

COMING MEETINGS AND EVENTS

American Ceramic Society's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

American Chemical Society, the Society of Chemical Industry and the American Section of the latter society will hold a joint meeting in New York, September 6 to 10.

American Electrochemical Society will hold its fall meeting in Lake Placid, N. Y., September 29 and 30, and October 1.

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The Blast Furnace *and* Steel Plant

Pittsburgh, August, 1921.

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